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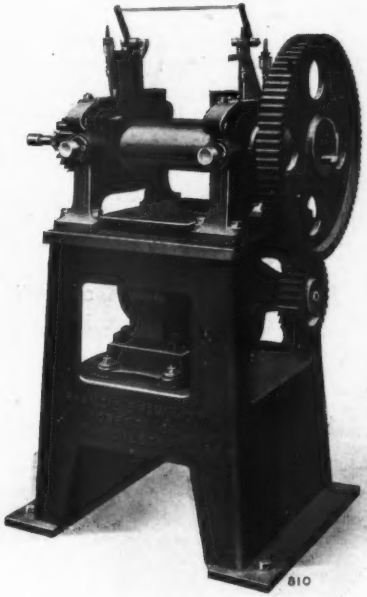

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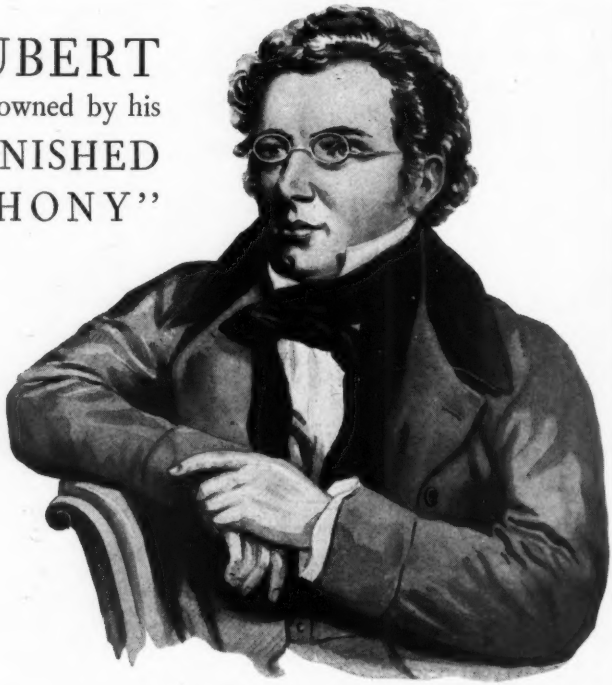

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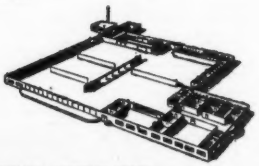

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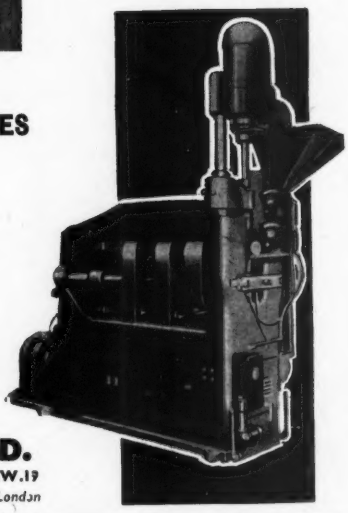

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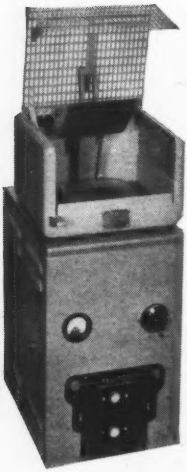

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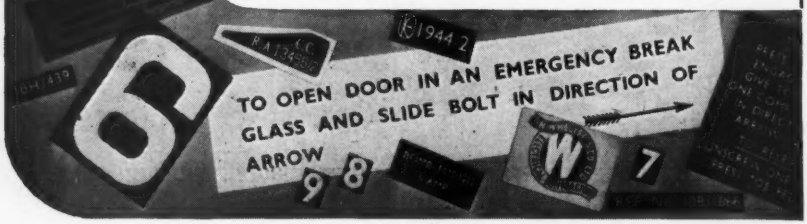

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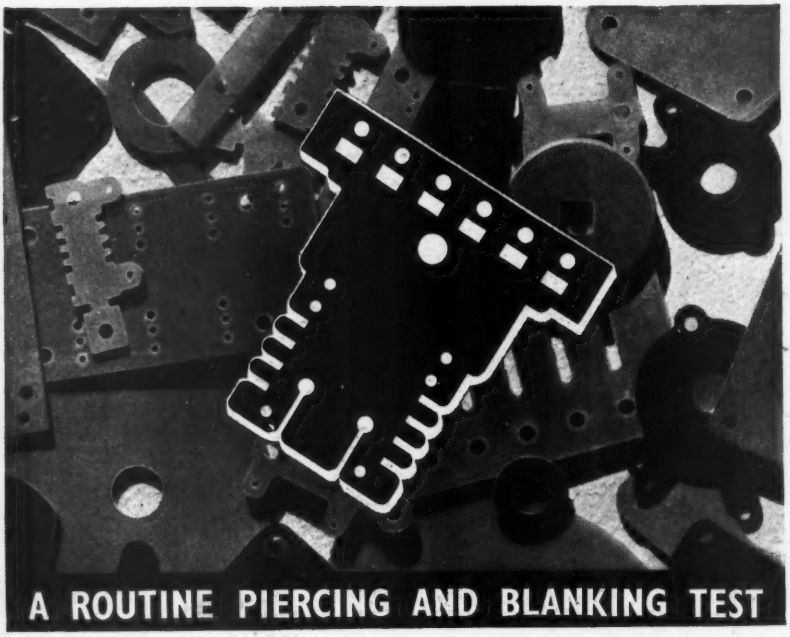

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Vol. IX. No. 102 NOVEMBER, 1945

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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NOTICES

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EDITORIALS

Paper for Laminates

IT is commonplace that of all the scientific industries, one of the most difficult and most open fields for research is in plastics, and it is in the industrial part of our industry, as distinct from the purely chemical and physical side of it, that least research has been done. We need not be surprised at this, since in manufacture we deal often with heterogeneous mixtures of large molecules with a frightening number of variables.

In the impregnating field, the conditions are possibly the worst of all. It was, therefore, with considerable pleasure that, on October 24 at the Waldorf Hotel, before the Institution of the Plastic Industry, we listened to a lecture by S. R. H. Edge and J. D. Morgan on "Recent Research on Paper for Laminated Plastics." It was remarkable for the fact that up to now so little has been done to examine the problem of making paper for laminated plastics. It was remarkable because it denoted a close co-operation to this end between a famous paper-making concern, Wiggins Teape and Co., and a famous resin-making company, British Resin Products.

The work discussed by the lecturers was mainly concerned with the development of laminated boards of good electrical insulation characteristics and of low water absorption. Mechanical strength was of secondary consideration. A variety of papers was employed to produce phenolic laminates, the resin being a phenolic resin (one of the cresylic Epok resins) used as a solution in industrial alcohol.

As an obvious first step, it was decided to examine the effect of varying the absorbency of the paper, the most absorbent being made by mere disintegration of Kraft in the beater with a roll high up, the less absorbent being made by prolonged beating. Impregnations of these papers were made with the resin solution with a solid content of 44 per cent. and boards were formed from the sheets at 155 degrees C. and 1,120 lb. per sq. in.

The following deductions were made:—

1. The more absorbent the original paper, the more resistant to water is the finished cured board.

2. Maximum shear strength parallel to the laminæ is obtained by using a paper of high absorbency.

3. The less absorbent the paper the lower the hardness of the resulting laminated board.

4. The absorbency of the paper does not appear to affect other mechanical properties.

It was realized, of course, that while the very water-absorbent papers were the obvious starting points for the production of sheets with a maximum absorption for alcoholic resin solutions, such absorbent papers would be too weak to use.

Therefore, in order to produce paper from completely unbeaten pulp the invention described in the Wiggins Teape patent B.P. 530,293 was used. This describes the addition of a water-soluble cellulose ether (preferably with alum) to the beater, to produce a paper of increased wet strength.

This treatment showed that the wet strength of the papers in alcohol is markedly increased by the addition of the ether and alum, and that the addition does not seriously affect the absorbency.

These preliminary experiments justified a full-scale trial and, accordingly, this Kraft sheet was prepared in the manner described and compared with a commercial high-grade Kraft paper normally used for electrical work. The following deductions were made:—

1. Water resistance of laminated boards made from this experimental unbeaten Kraft is much superior to that of boards made from commercial Kraft.

2. The mechanical properties of the

board using the absorbent paper under similar conditions of resin content are somewhat superior with the exception of impact strength, which is inferior.

3. Boards made from absorbent Kraft with lower resin content are superior in all mechanical properties and still possess better water resistance than do normal Kraft boards.

4. The electrical properties are at least as good as those found in boards made from normal Kraft paper.

The foregoing results warranted the examination of sheets made from unbeaten sisal, jute, straw and esparto and boards made with them.

Sisal did not prove of special interest, for with high alcohol absorption gave a less water resistant board than one made from Kraft paper with a lower absorption. Jute and esparto, however, proved of considerable value, esparto, for example, giving tensile and cross-break strengths somewhat higher than Kraft, while its shear strength parallel to the laminæ esparto was much the stronger. The water absorption of these esparto boards was 0.16 per cent. for quarter inch. Still more significant was the extremely low water absorption of esparto board (0.11 per cent. for quarter-inch thickness) made from esparto with fine fibres removed.

The Scientific Service

THE life of the scientist in the Civil Service has not been, in the past, an altogether agreeable one.

It is true that, like his opposite number in the non-scientific Civil Service, he has been the envy of all outside it. The far too long holidays with far too few working hours in the day; the inordinate "sick leave," which, in most cases, is nothing more than additional holidays; the security of tenure of his job (dismissal can only be secured by the clumsy murder of one's aunt)—all these are blazing attractions for most workers.

There is, however, another side to this rosy picture. His salary is, especially in the early stages of his career, but little higher than that of the municipal dustman. There is no chance of advancement, because of individual endeavour or brilliance since promotion is obtained only by the soul-destroying system of seniority. He is more or less completely cut off from the outside scientific world, more specifically the industrial world, receiving no knowledge therefrom and imparting none to it.

Many of these drawbacks will be removed in the future by the recent report of the Barlow Committee, now published as a White Paper. Set up by the Treasury to investigate the remuneration and conditions of service of scientists in the Government Departments, the Committee was composed of Sir Alan Barlow, Sir Edward Appleton, Secretary of the Department of Scientific Research; Mr. W. F. Lutyens, of Imperial Chemical Industries, Ltd.; and Professor E. K. Rideal, of the Department of Colloid Science, Cambridge University.

Not only will the more pleasant aspects of life in the Civil Service remain, but salaries are to be improved.

The present hermit life of the Civil Service, which prevents young scientists obtaining recognition for their labour and removes them from contact with the latest work in the Universities, learned societies and industry, will (it is pleasant to record) be destroyed. There are to be extra mural research contacts, there will be a system of temporary interchanges between Government departments, while University Departments will be encouraged to give staff leave (with pay) to attend scientific meetings.

We do not doubt that the country will eventually benefit by such wise steps, which we are sure will encourage the deserving and more brilliant workers. There is only one cloud which dims the prospect for the outside industrial world—the new scheme will attract far more workers to the Civil Service, which has steadily increased in the war years, at a time when industry needs them just as badly, and at a time when the Universities are turning them out at a comparatively low rate.

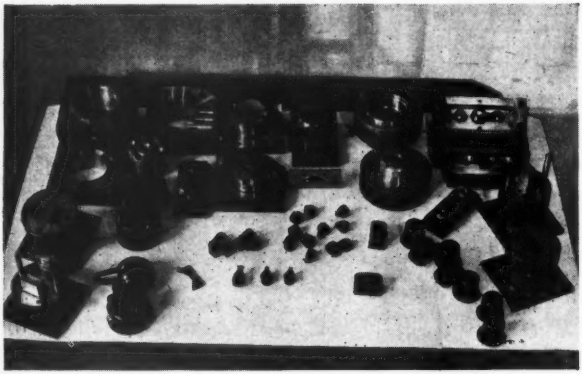

Fig. 1.—Examples of moulds and mouldings manufactured by R.E.M.E. workshops in the Middle East.

FRONT LINE PLASTICS

By Capt. F. J. W. BARTLETT,
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(Member of the Institute of the Plastics Industry)

We continue the story began last month on R.E.M.E.'s work on plastics in the N. African Campaign

Laminated Plastics

Laminated plastic materials are basically sheets of paper, cloth, wood plys, asbestos sheets, etc., coated or impregnated with synthetic resins, then compacted under heat and pressure to form relatively high-strength sheets or blocks.

The commercial phenolic laminates exhibit outstanding properties compared with simple compression mouldings. In compressive, tensile and impact strengths they are superior, but they cannot be formed into such complicated shapes as compression or injection mouldings. There are modern methods of forming laminated materials into simple shapes, but they will be considered here only in their flat forms.

Commercially, the laminates are formed by impregnating or spraying a fusible synthetic resin on to the base, e.g., canvas, evaporating the resin solvent and bonding the sheets of resin-treated material in a hydraulic press. Commercial phenolic resins are made which permit bonding with relatively low pressures and heating periods. The synthetic resins may be powdered over the sheets, or powder and liquid resins may be used in combination. Sheets can be made from 1/32 to 6 ins. thick, and innumerable combinations of canvas, wood, wood-asbestos, paper-wood, paper-linen, etc., produced. Tubes are easily manufactured by rolling impregnated strips. Such boards and tubes are excellent insulators, impervious to water, resilient, can be drilled, tapped and machined into silent gear wheels.

The synthetic resin adhesives used for these materials have been studied in great detail and comprehensive data have been published on them in the plastics Press. Resins derived from crescylic acids are principally employed for materials used as insulators. Phenolic resins from phenol are stated to give superior mechanical strength. An attempt to produce laminated materials from the tannin-

formaldehyde resins followed a demand for water resistant gaskets which could be produced by punching out on an ordinary press tool.

Without the syrupy type of synthetic resin or a solid which would dissolve in industrial spirit or acetone, the usual commercial methods could not be followed, therefore experiments were carried out with the precipitated resin. The powdered precipitate Q/4G.1 was thoroughly washed in dilute hydrochloric acid, followed by water, dried and laid evenly on to canvas sheets. The sheets were laid carefully one above the other and compacted with 1,500 lb./sq. in. pressure at 180 degrees C. for five minutes. Twenty-four sheets were compressed into a single laminate. The experiment was not entirely successful. Some of the laminæ separated when submerged for eight minutes in boiling water.

Repeating the experiments with varying curing times, pressures and temperatures showed this method of laminating to be unreliable. A solution of Quebracho in water was sprayed on to linen and paraformaldehyde (polymerized formaldehyde) powdered on to the linen. Making a paste was tried next with a lubricant incorporated. The results were better. Some hexamethylenetetramine was then manufactured with ammonia solution and formaldehyde. This, powdered, was then dissolved in water and added to a Quebracho solution containing ethylene glycol. After a few hours the viscosity of the solution increased and was then brushed on easily to the linen sheets. The sheets were allowed to dry slowly and then laminated. An excellent laminate resulted. Over 1,000 1-ft. sq. sheets ⅜-in. thick were manufactured and employed as punching material for washers. A few ¾-in. thick boards were made experimentally for test purposes. Later, asbestos and wood, canvas and cork and other sandwich materials were produced for various purposes. Scrap cork cuttings were milled and re-formed into sheets of different thicknesses. Fillers of powdered asbestos, paper, sawdust and chopped cord were dipped and used as "fillers" between the basic sheets of materials. Impregnated sheets of Indian hardwood were sprayed and laid up for 12 weeks, then compressed at 180 degrees C., 1,000 lb./sq. in. pressure for three minutes, and resulted in successful laminates. When paper sheets were treated in exactly the same way, some pre-curing had taken place before pressing. This was discovered during the tensile tests. It was believed the moisture content of the wood may have delayed polymerization of the resin. In order to guard against pre-curing during storage of the impregnated sheets, some sheets may have the Quebracho solution, lubricants and plasticizers, and others the hexamethylenetetramine. When these separately treated surfaces come into contact on the press, bonding takes place.

Eventually, the Hexa-Quebracho method was abandoned for the vastly superior method of using the resin formulated with Quebracho aniline hydrochloride and formaldehyde.

Moulding with Impregnated Preforms

In the usual form of compression moulding, powders or cold-compressed tablets are placed in the cavity of a metal mould and pressure exerted by the force of the mould. The plastic flows at a predetermined temperature and a chemical action takes place within the mould, resulting in a "cured" plastic moulding.

When the filler in the powder is of fine mesh, the relative strength of the moulding is not as great as that when cord or a long fibre filler is employed.

The move towards producing a high-strength plastic which could be moulded into reasonably complicated shapes, led to extensive experimenting by industrialists with chopped fabrics impregnated with various types of phenolic and urea resins.

Processes were also involved whereby paper pulps and wood sulphite pulps were incorporated with synthetic resins in papermaking machines; successful attempts have also been made to arrange the pulp fibres so that they inter-

lock or fibrillate. This mechanical arranging of the pulp fibres and their impregnation with a synthetic resin in a pulp-beating machine results in moulding materials which have much greater strengths than those made from powder and compare favourably with those of the laminates.

Preforming wet is a significant feature of the pulp impregnated mouldings. Claims are made that by suction forming the wet pulp over shaped gauze screens preforms are produced which, when dried (to a definite moisture content) and then moulded under heat and pressure, the strongest available deep draw plastic mouldings are produced.

The first experiments to produce high-strength plastics with the tannin plastics were not entirely successful. There was a large quantity of waste fibrous felt which had been used as packing for the lids of ammunition boxes. These felt sheets were approximately 2 ft. by 8 ins. by $\frac{1}{4}$ to $\frac{1}{2}$ in. thick. Pieces were cut from them nearing the shape of the Ford V8 rotor arm, and these preforms soaked in a 20 per cent. solution of Quebracho, to which had been added 10 c.c. of 25 per cent. hexamethylenetetramine solution, with a small amount of plasticizer and lubricant. After a few days in the solution the preforms were dried slowly, drilled to take a metal insert, and moulded in flash moulds. Most of the resin came to the surface of the mouldings, making them very brittle. After a few days the mouldings exhibited crazing. With separate sheets of impregnated canvas cut to shape and laid together wet, then dried and moulded as before, much stronger moulding resulted.

Calculations were made by experimenting with various solution strengths, and then the felt was impregnated under pressure. It was found that 35-40 per cent. of resin is required relative to the weight of the finished moulding. These mouldings were satisfactory, but after some days the outer surfaces showed some scaling of the resin.

The most satisfactory mouldings of this type were produced by a continuation of the precipitation process. One method employed required macerated paper pulp (received from a local paper manufacturer) wet formed over a wooden former and impregnated with an ammonium salt, lubricants and plasticizers. A shallow bowl about 14 ins. diameter was thus produced and then impregnated with a solution of Quebracho to precipitate the synthetic resin within the preform. After some variables had been tried, it was possible to apply heat and pressure to the preform and obtain a high strength, fully cured, moulding almost instantaneously. The moment heat and pressure are applied by the press to the cast metal mould containing the preform, curing is effected. Speed of production is governed by the time required to insert the preform, close the press, open it and remove the moulding. Manufacturing the wet preforms, however, is a slow process, and the tensile strengths of the mouldings only a little higher than powder compression mouldings. The method is excellent for synthetic resins possessing very little natural flow.

Practical Applications

Even with the rough-and-ready methods employed in the early days of the plastics workshop, sufficient powder was made to secure full operation of the moulds. It was a little while before a moulding technique for this particular material could be worked out, owing to lack of uniformity of the various batches of powder. Eventually, sufficient material was on hand to make batch averaging practicable. This brought the moulding powder to a stage of uniformity which made routine bulk production possible. When the crucial time had passed and it was convenient to study the material more scientifically, obtain plastics technical literature and manpower, ideas suggested en route were investigated. Among the most successful of these developments were:—

(i) Impregnation of unserviceable felt and fibre cut into shapes and moulded to form insulated sheets,

blocks, radio knobs and ashtrays for welfare departments.

(ii) Quebracho finely divided and added to a dry hardener, packed and despatched for dissolving in water to produce laminated woods from scrap paper. Salvaged tent canvas was turned into " linoleum "; unserviceable tracing cloth became high-strength boards; scrap asbestos sheet was laminated to wood, canvas and cloth for various requirements.

(iii) Top covers of Q/4G moulding powder a few thousandths of an inch thick were given to wooden boards. This coating resisted petrol, alcohol, burning cigarettes.

(iv) Wooden blocks were laminated under high pressure with pressure-impregnated processed Quebracho solution.

(v) A cold press tool punching type of laminate was produced for small high-tensile gaskets. These gaskets were boiling water-tight.

As only one grade of commercial powder was ever received and mouldings were demanded necessitating some changes in the qualities of the finished mouldings, the following routine procedure was suggested and adopted:—

1. The manufacture of serviceable moulding powders (phenol-formaldehyde type) of known commercial formulæ cannot be economically undertaken in this workshop. In order to produce such materials in the quantities the present demands indicate, would necessitate the construction of autoclaves, steam-heated mixing mills and the importation of raw materials from the U.K. or U.S.A. Commercial moulding powder now in stock is insufficient to meet actual demands. This material will take up a moulding commitment of approximately half that desired. The commercial material cannot be satisfactorily employed for three of the items waiting manufacture, e.g., cruciform resistance, which requires a material of a higher heat resistance and insulation value. In order to overcome these difficulties the following procedure is suggested:—

2. Without diminishing the properties of the finished mouldings and in some instances modifying them, the weight of the commercial powder can be extended to cover three times its effective weight. With the materials on hand this would cover all commitments and safeguard against unforeseen delay of promised supplies.

No additional apparatus is required. The only additional chemical necessary is available at the Salvage Depot.

3. The following are the relative values of Commercial Powder (C) to Extended Powder (E):—

	C powder (Woodflour filled)	E powder (Woodflour filled)
Tensile strength	Standard	Equal or improved
Impact	Standard	Equal or improved
Dielectric ..	Standard	Generally slightly lower. (Higher if mica filled)
Water absorption	Standard	Generally slightly higher
Specific gravity..	Standard	Can be made equal or less
Bulk factor ..	Standard	Generally slightly higher
Machinability	Standard	Can be controlled to be inferior or improved
Heat resistance..	Standard	Can be controlled to be inferior or improved
Moulding conditions		
Temp. ..	Standard	Generally slightly higher
Pressure ..	Standard	Generally slightly higher
Cure time ..	Standard	Can be controlled to longer or shorter period
Moulds		
Action on steels	Standard	Equal

Alteration of the fillers and modification of the production process materials changes the properties of the mouldings. In effect, the extended powder produces mouldings as serviceable, according to the properties required, as the commercial powder. It is pointed out that the locally manufactured powder can be made to produce satisfactory mouldings without the addition of the commercial powder, but this procedure is not now practicable on a large scale, due to the lack of some essential chemicals.

Before the eventual closing down of the Plastics Workshop in the Middle East, attempts were made to further improve the Quebracho moulding powders and laminating solutions by co-polymerizing the synthetic resins produced with synthetics of the aniline-hydrochloride-formaldehyde types. Experimental work was also done on casting resins, low-pressure laminates, and the incorporation of special fillers, such as Bargasse, chopped cord and scrap cotton. Some trouble was experienced with fungus growths during storage, but the incorporation of small percentages of anti-fungicides obviated this trouble.

It should be noted that the tannin extracts from which the plastics were developed are of plant origin. In order to bring the bulk of the raw materials required within a tropical plant category, research work was carried out on Mimosa extract plus furfuraldehyde evolved from cotton-seed husks. Although only in a laboratory stage and probably of little commercial value, mouldings can be made this way. Urine was made to replace the ammonium salt. Considerable work was done by civilian research chemists in India with coffee beans, from which a protein plastic was developed. Comparative tests, apart from the ease of manufacture, put the Quebracho plastics well ahead of this type of moulding material. Zein plastics, which are produced from a by-product of corn, are also more difficult to manufacture and show greater water absorption than do the Quebracho plastics. A continuous process for the production of Q/4G powder was worked out theoretically, but not put into effect owing to the ease with which the material could be simply processed by unskilled native labour.

Designing the Mould

In mould design and manufacture, past experience and the careful study of previously produced moulds and mouldings is of great assistance. The behaviour of the plastic material in the mould and after "curing" or "setting" tends to influence the decision of whether the moulding should remain in the cavity or on the punch. Mouldings shrink away from cavities, and therefore tighten on to any male members. This contraction varies between 0.005 to 0.010 in. per linear inch, and it is usual to estimate the shrinkage with mouldings of discs produced under similar conditions to those under which the material will be operated on a large scale.

The many details of mould design, such as slight tapers to facilitate ejection of the moulding, adequate thickness of walls relative to the pressures employed, sturdy core pins and as few separate mould members as possible, are basically commonsense engineering. There are, however,

Fig. 2.—Some of these press tools manufactured by the R.E.M.E. workshops in the Middle East were used for punching laminated plastics materials.

special problems which occur from time to time which can be solved more rapidly if the present facilities of the moulding and engineering shops can be scientifically reviewed. Each new mould is a problem on its own, but it usually bears some relation to an earlier model. An efficient record of the details of every mould which has done its job and has been laid up in the stores is essential. It is, perhaps, even more important to be able to recall the many operations of mould manufacture, moulding, and facilities for heating, etc., which can be applied in a particular instance. This is most important when other duties, apart from the job in hand, demand attention.

The Appendix, " Particulars of Sample and Mould Required," was drawn up with a view to co-relating various operators' ideas before final decisions were made. This procedure was quite simple. The relevant people examined the moulding or drawing of the moulding, went through their list noting, for example, that " 2/MS contact insert/chrome steel bush insert/1 P.F./7b/14a/16a/17b/21a.b. 22 ' Marine rotor.' "

For this moulding everyone agreed that the mould should be a transfer type with bottom ejection, but a healthy discussion ensued regarding a satisfactory method of locating the metallic inserts in the mould. It was inevitable that opinions would sometimes clash, but this not only stimulated organized thinking, but made everyone concerned feel he was an essential part of the scheme.

APPENDIX

Particulars of Sample and Mould Required

1. Preliminary Data:—

Specification of plastics material(s) required; specification of metallic and/or non-metallic inserts; specifications of any other materials to be employed for the finished mouldings; dimensions of sample and tolerances of moulding; dimensions of moulding on drawing; possibilities of fabricating a sample of mouldings required.

2. Examination of the Sample or Drawing of Article:—

Previous methods employed for moulding; practicability of moulding article as shown on drawing.

Design mould cavity for:—

Powder; powder and preform; soft or hard preform; shaped preform.

3. Machinery Available for Preform Production:—

Preforming press; stamping press.

4. Incorporation of Inserts:—

Precision fit in mould; screwed or clamped in mould; set in the preform; set in the finished moulding; non-metallic supports.

5. Finishing and Assembly:—

Cleaning off flash; filing, tumbling, buffing; machining of inserts; machining of moulding or moulded components; assembly of moulded components (same materials); assembly of moulded components (different materials); assembly of metallic components; cementing, painting, engraving, metallizing.

6. Type of Press Available:—

Upstroke; downstroke; automatic; semi-automatic; angle; combination; hand-operated, power-operated, hydraulic.

7. Type of Ejection on Press or Otherwise Available:—

Built into press, top/bottom, hand/power, number; bench ejectors, top/bottom, hand/power, number; slide on rails; compressed air; portable hand tool.

8. Accessories:—

Hopper feed on press; loading tray.

9. Transfer:—

Transfer plunger on top platen; transfer plunger on bottom platen; transfer plunger(s) at side of press; dimensions of transfer pot(s), plunger(s); dimensions of nozzles; number of nozzles; types and sizes of gates; method of ejection (sprues, moulding); mould clamping arrangements; venting.

10. Selection of Mould Type:—

Flash: horizontal, vertical, combination; positive; semi-positive; combination; horizontal; single cavity; multiple cavity; split; portable; static; floating.

11. Ejectors in Mould (as distinct from those attached to Press):—

Bottom; top; side; combination.

12. Methods of Effecting Ejection:—

Variation in temperature (force and cavity); undercut; flash; with insert; puller pin; thread; negative taper.

13. Nomenclature of Mould Parts and Accessories:—

Force; cavity; core pins; dowels; ejector rods; stripper plate; ejector springs; side core; lands; parting slots; chase; stripper

fork; bolster; shoes; threaded cores; insert plate.

14. Manufacture:—
Hobbing; turning; shaping; milling; die-sinking; drilling; slotting; routing; fitting; assembling; testing (on bench); hardening; testing (on press).

15. Other Details for Consideration:—
Chamfers; minimum working surfaces; no undercuts (unless especially required); efficient ejector pins; running-in; lubricating; prepare surfaces for chromium plating; mirror finish with emery cloth, buffs; break up large flat surfaces; finish, etched, sand-blasted, electrolytically polished, engraved, matted; prevent trapping of air in moulds; uniform heating (unless varying temperatures are required); allowances for contractions of moulded threads; tolerances and allowances general and special; jigs for semi-cured mouldings or fitting of moulded components; plan of set-up of mould and press; forecast of possible difficulties.

16. Heating of Mould or Plastic Materials:—
Steam-heated platens; electrical low voltage; electrical high frequency; superheated water; gas; combination.

17. Assistance from Past Experience:—
(a) Compare Moulding No. ..... with following changes .....
(b) Compare Mould No. ..... with following changes .....

18. Suggested Modifications of Sample:—
Design; materials.

19. Plan of Manufacture with Shops Involved.

20. Analysis of Metallic Inserts .....

21. Analysis of Organic Inserts .....

22. Estimated Date of Completion of Mould.

23. Estimated Date of Completion of Sample.

24. Estimated Date of Commencement of Moulding.

25. Estimated Date of Completion of Moulding.

26. Results of Inspections and Tests on Finished Mouldings.

Moulds and Moulding

The general commercial practice of employing semi-positive moulds was adopted whenever possible. Flash moulds for rotor buttons produced excellent mouldings. From time to time it was necessary to change from compression moulding procedure and resort to transfer moulding, i.e., putting the material in a cavity at the top of the mould and squeezing the heated material through a nozzle into the cavity proper.

Each of the moulds manufactured had a special reason for existence; thus although heavy tractor rotors could be readily produced by flash moulding, it was advisable to employ semi-positive moulds in order to increase the tensile strength of the mouldings. Mild steel was at first used for moulds; later, captured Italian high-tensile steel was found more satisfactory. The tannin plastics—Qubrite 1 (woodflour filled), Qubrite 2 (asbestos filled), etc.—are thermosetting, i.e., when heat and pressure has been applied to the powder in the mould the moulding cannot be

General Properties of Tannin Plastics (Compression Moulded).

Specimen No.	Filler	Water absorption 24 hrs. at 20°C. Colour, dark brown or black	Specific gravity at °C.	Dielectric short time, volts per mil.	Tensile, lb./sq. in.
C 1	Woodflour	0.4	1.42	250–300	3,500–10,000
C 2	Woodflour/cotton	0.5	1.46	150–250	4,000–10,000
C 3	Cotton	0.5	1.35	150–200	4,000–10,000
C 4	Asbestos	1.2	1.86	100–200	3,000– 9,000
C 5	Asbestos/woodflour	1.0	1.66	150–200	3,000–10,000
C 6	Lignin	0.6	1.42	250–350	4,500–10,000
A 7	Asbestos/lignin	0.3	1.53	150–300	3,500–10,000
C 8	Mica	0.2	1.72	250–350	2,500– 9,000
A 9	Mica/asbestos	0.2	1.80	200–300	3,000– 9,000
A 10	Chopped canvas (new)	0.3	1.43	200–300	5,500–11,000
A 11	Kraft paper	0.40	1.38	200–350	3,500–10,000
A 12	Mimosa bark pulp	0.30	1.36	200–350	4,000–10,000
A 13	Chopped canvas (old)	0.45	1.42	150–250	6,500–12,000
A 14	Woodflour	0.25	1.38	250–350	4,000–11,000
A 15	Paper pulp	0.35	1.53	150–250	3,500–10,000
A 16	Mica	0.09	1.68	200–350	3,000–11,000

A.—Plasticized with aniline formaldehyde. C.—Plasticized with cresol formaldehyde.

powdered and moulded again. Polishing the mould surfaces made ejection of the moulding much easier. Chromium plating was tried, but was unsatisfactorily carried out by civilian firms and was abandoned in preference to high polishing on flexible shafts attached to the optical machines. For the early mouldings, hand moulds, which had to be taken off the press to eject the moulding, were found quicker to manufacture. Eventually 65-ton downstroke axle-straightening presses were converted to take electrical elements thermostatically controlled. The ratchet at the side of the press was advanced nearer to the cylinder and used as an upstroke ejector. To the ram of the press the top half of the mould was attached with a standardized fitting. The mould cavity for rotor moulds was standardized to fit on the bottom platen. Most powders were preformed cold to the rough shape of the moulding. This was essential when flash moulds were employed. Most measurements of powders in the moulding shop were done volumetrically with adjustable cups. A steam-heated platen press driven by a pump was used for the manufacture of laminated sheets.

Moulding the Qubrite plastics required temperatures of from 150 degrees to 180 degrees C. Curing times varied from 3 seconds to 2.5 minutes. Pressures varied from 1,000 to 2,500 lb./sq. in.

Postscript

Since writing the above, the writer has discovered that a process employing similar tannin extracts to those set out, exists.

The method outlined does not appear to have been developed commercially or given such favourable results as those obtained with the processes developed by the writer and his co-workers. The methods given here for plasticizing the tannin moulding powders with synthetic resins derived from aniline-formaldehyde and other synthetic resins are apparently original. Such processes as outlined are, until further notice, the property of H.M. Government.

AEROLITE AND REDUX

The November, 1945, issue of the Aero Research Bulletin, published by Aero Research, Ltd., of Duxford, Cambridge, has just been issued. It contains much interesting information on the use of these well-known adhesives in the first British air liner designed to meet the demand for passenger transport in the near future, details of which have hitherto been kept secret.

The Vickers Viking—the first peace-time air liner to employ synthetic Aerolite glues for stressed areas—is a twin-engined low-mid-wing metal monoplane of completely new design, yet with lines suggestive of its worthy ancestry.

The Viking has a still-air range up to 1,600 miles, and taking off with its all-up weight of 33,000 lb. it is 50 ft. clear of the ground in 850 yds. The test flights of the Viking took place in the record time of 7½ months after completion of the drawing-board stage. Actual performance figures have exceeded estimates by a very satisfactory margin.

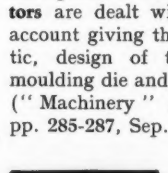
The design of a suitable flooring for this class of aircraft has always been a problem because of the uncertain nature of the load application. The use of closely spaced stringers in supporting the floor reduces the need for strength and weight in the surfacing material, but it is disadvantageous because of a prohibitive number of rivets and mechanical fixings. This problem has been neatly solved by the use of Aerolite and Redux adhesives in the flooring of the Viking, the whole structure being rivetless composite assembly of metal and plywood of great strength and otherwise unattainable lightness. Birch veneers are bonded to the upper faces of the metal floor stringers by the Redux process, pressure and temperature control being maintained. (For full particulars of the Redux process for bonding metal to wood, refer to the Special Bulletin of April, 1943.) The actual floor surface, composed of plywood, is then glued to the veneered stringers by means of Aerolite glue, and the finished job succeeds in being astonishingly robust and at the same time lighter than by older methods of construction.

World's Industry Employs Plastics

ELECTRICAL

New clamp for tube and conduit installations has been developed by the Glenn L. Martin Co. It consists of two parts—a base and a ring. The base, of hook shape, can be made of metal or plastic and is fixed to the wall by an ordinary screw; the ring shape member is made of a high-grade synthetic rubber; it is slung round the tube and the clamp, and, with a single twisting movement, the tube is held in place. ("Compressed Air Magaz., Vol. 50, 1945, p. 252, Sep.) **Moulded Tenite connector plugs** for American Air Force electrically wired flying suits are snapped on to arms and legs; they cannot accidentally become disconnected unless two small buttons on either side are pushed against the strips holding the prongs in place. ("Autom. and Av. Ind.," Vol. 93, 1945, p. 116, Aug. 15.) **Six-unit coaxial cable** contains in every mile run 507,000 small insulating discs to keep the wire within it from contact with the cylindrical outer conductor. Originally hard rubber was used, but now polythene is employed. This shows much better electrical characteristics, in particular, 1/12 of the shunt losses. The dielectric constant is about 2/3. (C. Kreisler in "Bell Laboratories Record," Vol. 23, 1945, pp. 321-324.) **Methods for testing finished plastic mouldings** have been summarized (as a report by Sheerman, Fleming-Williams, Rogowsky and Strong) by British Electrical and Allied Industries Research Ass. (price 34s. 6d.). The work was done at the request of the British Standards Institution, and tests are described for impact strength, cross-breaking strength, crushing strength, electric strength, surface resistivity, plastic yield with temperature, resistance to heat (glowbar), specific gravity and water absorption. **Plastic moulded commutators** are dealt with in a comprehensive account giving the properties of the plastic, design of the assembling fixture, moulding die and the moulding operation. ("Machinery" (Lond.), Vol. 67, 1945, pp. 285-287, Sep. 13.)

GENERAL ENGINEERING



Bonding of metal to rubber is dealt with in an account covering the "brass-plating" process which allows all types of ferrous and non-ferrous metals to be so bonded. ("Mechanical World," Vol. 48, 1945, pp. 324, 325, Sep. 21.) The article is based on information from Rubber Bonders, Ltd., Dunstable, Beds. **"Silastic," a silicone elastomer** produced by Dow Corning Co., is now available in various stocks for moulding, extruding, coating and laminating. Owing to their chemical structure, these rubbery organo-silicon oxide polymers are said to remain elastic after heating up to 500 degrees F. (260 degrees C.), and retain flexibility even at minus 70 degrees F. (– 57 degrees C.). "Silastic"-coated lead wire and other shapes are produced by extruding. By coating glass or asbestos cloth flexible, waterproof, heat-stable, oil-resistant gaskets, diaphragms, etc., are produced; they are claimed to be non-tracking, arc and oxidation resistant. ("Products Finishing," Vol. 9, 1945, p. 120, Sep.) **Swiss Association for material testing** has recently published the following proposals dealing with the testing of thermosetting plastics: tensile tests, com-

pressive test, bending test, shear test, impact bending test, hardness testing according to Vickers (" Schweiz, Archiv f. angew. Wiss. and Technik," Vol. 10, 1944, pp. 287-294, Sep., pp. 323-330, Oct., and pp. 360-362, Nov.) Another series of proposals deals with dielectric strength, dielectric constant and loss factor; thermal expansion, specific gravity and modulus of elasticity; thermal resistance and decomposition temperature. **Automatic ball sorter,** by Jack and Heintz, is equipped with a Plexiglas stopper. (" Autom. and Av. Ind.," Vol. 93, 1945, p. 64, Aug. 1.) **Transparent oil cans** of injection moulded plastic are made by Standard Moulding Corp., Dayton, Ohio. (" Autom. and Av. Industries," Vol. 93, 1945, p. 44, Sep. 1.) Considerations for the **practical application of plastic bearings for rolling mills and a comparison with metal bearings** are given by S. Staton (" Mechanical World," Vol. 118, 1945, pp. 257-266, Sep. 7). Whilst the advantages of these bearings—low friction, reduced wear and, therefore, low maintenance costs—have been fully realized in Germany and America, British users of rolling mills have not yet made enough use of this cost-saving device. As plastics have no " yield " limit, working stress has to be fixed by experience or conjecture. J. Delmonte makes an advance to solve this problem (" Transact. A.S.M.E.," Vol. 67, 1945, pp. 477-481) by obtaining elastic limit stress data by a beam deflection method. He suggests also a curve-deviation method by which elastic limits can be more accurately determined than by the conventional stress-strain technique. The following materials were tested:—Moulded, rag-filled phenol resin, cellulose-acetate sheet, laminated phenolics, woodflour-filled phenolic resin and polymethyl-methyacrylate sheet. **Phenolic fibres, i.e., cotton-base laminates impregnated with phenolic resins,** belong to the new materials developed during the war and seem to have a promising future in the years to come. G. E. Stedman discusses their characteristics, design features, fabricating behaviour, etc., from experience gained in several B-25 bomber components. (" Metals and Alloys," Vol. 22, 1945, pp. 1658-1662, June.) **Laminated brace for Radar** is described in " Plastics " (U.S.A.), October, 1945 (page 52). The basic material employed is glass cloth impregnated with Laminac (American Cyanamid Co.) wound into tubular form on mandrels. The final shape is that of a letter " A," the whole structure being very strong and transparent to radio frequencies. **Cyclone Generator** has been evolved by Plastic Spray, Ltd., London, to supply the heat treatment for Plastoglaze materials. The generator produces a mixture of chemically loaded gases which are directed on to the coated surface by means of flexible hoses. The apparatus is portable, and can be used both in and out of doors, the area of the surface treated being unlimited. In dealing with a quantity of small articles, a generator cabinet, into which the gases are passed, is recommended. The gases, which are neither inflammable nor injurious, quickly raise the temperature of the coating to a point at which hardening occurs rapidly. Furthermore, the flow of gases assists the removal of the solvents from the coating and leaves a smooth hard surface.

MOTORS

Composite plastic station - wagon - type body composed of complete sub-assemblies which can be either assembled at the producers' works or direct on the automobile production line, has been designed by Tjaarda. Improvements include vacuum-operated automatic windows and form fitting latex seats. The body material is said to be impervious to weather conditions, light in weight, exceptionally strong, and with high insulation qualities. (" Autom. and Av. Ind.," Vol. 93, 1945, p. 87, Sep. 1.) **Plastics for post-war car and aeroplane** are discussed by Knettel, who enumerates the general properties of typical commercial plastics and

given limits for their application. One development worth mentioning is headlight lenses of moulded polymethylmethacrylate. They have already been used in the sealed-beam headlamps of American amphibious tanks because of their light weight, resistance to breakage and increased light transmission. ("Autom. and Aviation Ind.," Vol. 93, 1945, pp. 34-36, 88, 90, 92, Aug. 15.)

MISCELLANEOUS

Survey of commercial thermoplastic synthetic resins is given in a data sheet stating composition, strength, heat resistance, resistance to acids and alkalis, water resistance, colours, trade names and typical uses; seven different plastics are listed. ("Metals and Alloys," Vol. 22, 1945, pp. 451, 452, Aug.) Goodyear is erecting a **Vinyl plastics plant at Niagara Falls for manufacture of transparent packaging film,** for wire insulation, fabric coatings, flooring, wall coverings and adhesives, with a production capacity of 3,000,000 lb. per year. ("Autom. and Av. Ind.," Vol. 93, 1945, p. 110, Aug. 15.) Zinc-Alloy Die Casters Association has prepared a 16-page booklet **comparing the plastic mouldings with the zinc-alloy die castings.** The booklet presents valuable data which may facilitate the selection of the optimum material for a given article. A part of this brochure deals with the combination of the two materials and several illustrations show how the greater strength of the die-casting is combined with the valuable properties of thermosetting and thermoplastic materials, which, for obvious reasons, usually serve as the outside cover. **Gummed plastic** plate has been developed by Pennsylvania Plastics Corp. which is said to adhere and remain permanently bonded to any clean surface when moistened with solvents such as benzene, naphtha, etc. Offered in a great range of permanent colours, the plate is available also with fluorescent and phosphorescent letters. ("Products Finishing," Vol. 9, 1945, p. 114, Sep.) **Methods for determining the flashpoint,** i.e., the decomposition point, of organic insulating materials has been given by M. Zuercher. ("Schweiz. Archiv, f. angew. Wissenschaft und Technik," Vol. 11, 1945, p. 94-96, March.) Decomposition diagrams plotting temperature in relation to time of nine different plastics are given, such as aminoplast, celluloid, plexiglas, thermosetting resin and laminated paper. Recent investigations on the reaction which takes place in the formation of curing of phenolformaldehyde are surveyed by Keld. In this article ("Schweiz. Archiv, f. angew, Wissenschaft und Technik," Vol. 10, 1944, pp. 280-285, Sep.) some recent English literature has also been considered. **Four basic types of moulds used for thermosetting plastics,** fully positive types, flash type, landed positive type, semi-positive type with flash ridges and telescoping parts, are clearly described by D. M. Buchanan, and practical hints are given on the correct choice. ("The Machinist," Vol. 89, 1945, pp. 725-728, Sep. 1.) **Good preforming and preheating methods insure satisfactory moulding,** but the proper selection of a preforming and preheating method is, according to D. M. Buchanan, dependent on the variables of design, moulding composition and economics. ("The Machinist," Vol. 89, 1945, pp. 905-908, Oct. 6.) The article contains a trouble shooting chart for plastic mouldings, which may prove very valuable. **New Oldofredi process for embossing** uses wire mesh as a die; it receives, retains and transfers any pattern or design incorporated in it. Besides metallic mesh, meshes woven of plastics and non-metallic strands have been used. ("Wire and Wire Products," Vol. 20, 1945, pp. 626, 627, Sep.) **Inexpensive constant humidity room** has been built at Southern Regional Research Laboratory for controlling the moisture content of wood and glued samples used in block and plywood shear tests. ("Mechanical Engineering," Vol. 67, 1945, pp. 475, 476, July.)

Manufacture of Brake Linings

By Dr. B. S. GIDVANI, D.I.C., F.R.I.C., A.M.I.Chem.E.

IN a vehicle driven by an internal-combustion engine, provision must be made for halting suddenly in an emergency without stopping the engine. During the past 20 years considerable developments have taken place in the motorcar industry; speed has become higher and higher and the roads more and more crowded, so that efficient braking has become a matter of urgent necessity in the interests of both safety and average speed. Various braking systems have been evolved which need not be described in the present article.

Formerly the expanding or the contracting member of the brake was made in two halves, hinged together, and the friction was obtained by a metal-to-metal contact with the brake drum. As the friction between metallic surfaces is comparatively low, being insufficient for sudden jerkless stopping of a car running at some speed, some friction lining such as camels' hair belting or ordinary leather treated with Neat's foot-oil was used. These were found to be unsatisfactory since at the high temperatures generated in sudden braking, they invariably burnt out.

Functions and Results of Braking

Bringing to rest of a moving body by braking is accompanied by the conversion of its inertia into heat. The transformation of motion into heat is gradual and progressive, but at any time during braking, the sum total of these two kinds of energy is constant. Just before the brakes are applied, it is all motion and no heat, while just when the car has come to a standstill, it is all heat and no motion. The heat so produced is absorbed mostly by the metallic brake drum and partly conducted by the brake lining to the metallic brake shoe. During a normal stop, the temperature of the brake drum may rise to 150 degrees C. or more. With the release of the brakes, the contact between the brake lining and the drum is broken and both start to cool. However, dragging of the brakes or repeated braking in frequent succession, does not allow complete dissipation of all the heat to the atmosphere as the brake drum and the lining are not apart for a sufficient interval to cool off and the temperature of the former may rise to well over 300 degrees C.

Although brakes have been used for the past 170 years, the first non-burning brake lining appeared only 40 years back. It consisted of a closely woven fabric made from long silky fibres of Chrysotile asbestos. Due to the poor wearing properties of this fabric, asbestos was reinforced by adding first flax and later cotton fibres. A patent was taken out in 1911 in U.S.A. for interweaving wire with asbestos and cotton yarn and was claimed to give great strength and increased conductivity to the lining.

Plain asbestos-cotton-wire fabric without further treatment is not used in modern practice, as it is highly susceptible to moisture with consequent alternations in its frictional properties, also its life is very short, due to rapid wearing. The water of crystallization of asbestos, which it will be remembered has the chemical formula $3MgO.\ 2SiO_2\ 2H_2O$, is driven out by the heat generated in braking and the asbestos is reduced to fine powder. The fabric is therefore treated with some impregnating compound, usually called the binder, to make it waterproof and heat resistant. The life and the wearing properties of the brake lining depend to a great extent on the binder.

Binders

Various types of impregnating compounds have been used which may be classified under four main headings:—

(1) Drying oils, (2) resins, (3) bitumens, and (4) rubber compounds.

Drying Oils

The oil most commonly employed, either singly or in conjunction with other oils or some other binders from a different group, is linseed oil. Tung oil is a close rival, although in the patent literature, oils of all sorts, specially those of poppy-seed, hempseed, walnut, safflower and sunflower have been mentioned.

Drying of these oils by exposure to air is slow, and therefore in the manufacture of the brake linings, is accelerated by baking at relatively high temperatures. Oxidizing accelerators such as litharge, manganese oxide, manganese borate and organo-metallic driers, such as cobalt, lead and manganese linoleates, naphthenates and resinates are also added to further shorten the drying time. Hardening is also hastened by heating in presence of hydrogen gas, though in the brake-lining industry, is seldom used.

Linseed oil is generally employed to impart body to the woven lining. It has a tendency to surface-dry which prevents the interior from complete hardening. When used singly, curing is carried out in presence of an inert gas like nitrogen or carbon dioxide. Nowadays it is very rarely used singly, but always in combination with Chinawood oil.

Sulphonated linseed oil is occasionally used either singly or in conjunction with plain or sulphonated tung oil. The friction property is greater when mixed with plain tung oil than when both are sulphonated.

Both linseed and tung oil are usually employed in combination with resins and bitumens in the form of baking varnishes.

Resins

Many synthetic resins of thermo-setting type have at one or the other time, been suggested as binders for brake linings, but in practice, the field is exclusively confined to those produced by the reaction of formaldehyde with either phenols of urea. Casein-formaldehyde resins and glyptals have also been used, but their use is very limited, at least in this country.

Natural resins are not employed as none of them is truly thermo-setting, although mention may be made of rosin, which is used for modifying phenolic resins to produce oil-solubility. Shellac, rosin and dammar are sometimes used in conjunction with rubber and drying oils in brake linings.

Phenolic resins, especially those produced by the action of formaldehyde or hexamethylene tetramine with cresylic acid are, by far, the most commonly employed resins and are used in viscous liquid or a powder form. Urea and casein resins, on the other hand, are usually employed as water solutions. Synthetic resins are also used in mixtures of bitumens, drying-oils both plain and sulphonated, semi-drying oils such as cotton seed and soya bean oils, rubber and natural resins and gums.

Oil soluble phenolic resins are quite frequently used and rosin modified phenolics which are fusible but soluble in oils are also occasionally incorporated in binding compounds.

Bitumens

Besides asphalts, tars and pitches are generally included in this group.

Gilsonite is the most commonly employed natural asphalt as brake lining binder, although other asphalts as well as fusible waxes, such as ozokerite and montana wax, are also often incorporated.

Gilsonite is generally used from a solution of petrol, white spirit, heavy oils or carbon bisulphide, but occasionally water dispersions are met. It is not completely soluble below 150 degrees C., but remains colloidally dispersed, and when used in this form there is a tendency to surface-deposit on the lining, due to the filtering action of the asbestos fibres. If great care is not exercised with such a solution, as much as one-third of the total gilsonite may deposit on the surface, which gives a false friction characteristic to the lining.

When high temperatures are generated as in repeated rapid stops, gilsonite becomes soft and gummy and sticks to the drum if the brake is set while the drum is still very hot. By heating with

sulphur at 250-300 degrees C. it can be converted to an infusible form, and it is preferable to use it in this form.

Asphalts are employed for their water-proofing and friction properties, while the tars are generally used for colouring and bodying the impregnating liquid.

Among the tars, water gas tar is the commonest, while coal and wood tars are also occasionally employed. Tars serve as vehicle for other binders. Water gas tar contains oils, but is free from carbon, while coal tar has a large quantity of free carbon. Consequently, the former hardens at high temperatures, and hardening continues progressively in braking services, while the latter forms sticky gums at high temperature, which would increase its friction value.

All the bituminous materials may be used either singly or in mixtures with resins, oils or rubber compounds.

Rubber Compounds

Rubber, on heat treatment, becomes plastic to a point where it will flow freely and can penetrate at least partially the fibres of an asbestos fabric. Complete impregnation can, however, be achieved on steam-heated rolls which are commonly employed for compounding rubber with other ingredients in the rubber industry.

Rubber, in its raw stage, is thermo-plastic and as such cannot be of much value in the brake lining where the temperatures of the order of 150 degrees C. are quite common, but by heating with sulphur and other ingredients it can be thermo-hardened. Vulcanized rubber compounds have certain properties which are highly desirable for brake linings, and in U.S.A. most of the brake linings always contain some proportion of such compounds.

Rubber in almost all forms, such as latex, rubber powder, smoked rubber, pale, crepe rubber, and even reclaimed rubber, has been used in the manufacture of brake linings. Reclaimed rubber from scrapped tyres and other rubber goods has poor properties as compared with the raw rubber and consequently its use in the brake linings is limited to only small quantities.

Vulcanization of rubber with sulphur or other vulcanizing agents, such as sulphur dioxide, carbon sulphide, hydrogen sulphide, selenium, lead, zinc and antimony sulphides, etc., under heat and pressure, is a slow process even at a temperature of 160 degrees C. Rubber industry has, therefore, developed accelerators, both organic and inorganic, to hasten the rate of vulcanization. Salts of guanidine and of thiazole type are by far the best organic accelerators while from the second category, zinc oxide, litharge and lime are the most commonly employed in brake-lining compounds.

Reinforcing agents and fillers commonly used in the rubber industry are employed. Examples are carbon black, zinc oxide, barium sulphate, clay, barium carbonate, whitening and Fullers' earth.

Types of Brake Linings

Three types of brake linings are available, namely, the woven, the moulded asbestos fabric and the moulded asbestos fibre linings. The first consists of an asbestos-cotton-wire fabric, impregnated with some binder and calendered to size. In the second type the impregnated fabric is further covered on the calender with some other friction compound moulded to size in cold and cured under heat and pressure. The moulded fibre lining, on the other hand, is prepared by moulding loose asbestos fibres which have been previously saturated with the binder.

Woven Linings

A hard, dense fabric is woven from Chrysotile asbestos, long staple cotton and thin brass wire, although, in recent years, brass has been replaced by lead and zinc alloy wires. Wire is introduced in the production of a hand-twisted yarn to strengthen it and enable it to resist the heavy tension employed in the weaving of high-quality closely woven fabrics. Wire also increases the resistance of the material against compression and spreading.

Many patents have been obtained for methods of weaving and for various

designs and patterns such as single ply, two ply double plain, single binder, two ply double plain single binder gutted, three ply triple plain single alternate binder, ribbon tape, braided weaving, etc., for each of which various claims have been made. The proportions of the materials in the fabric vary widely, but generally the composition is within the following limits:—

Asbestos 40-65 per cent.
Cotton 5-20 per cent.
Wire 20-40 per cent.

The fabric is then impregnated with the binder, of which, depending upon the binder and the fabric, 5-15 per cent. on the weight of the fabric is generally required.

The importance of the binder cannot be over-emphasized, as on the proper impregnation of the fabric lies the secret of quality and resistance to wear of the brake lining.

It will be clear from the foregoing remarks that the vital constituent of woven lining is the binder. Its complete penetration into the fabric is also of the utmost importance, since, however good the binder may be, the penetration must be complete, otherwise untreated portions of the fabric would be liable to wear out rapidly. Consequently, various processes have been developed to force a known quantity of the binder in a known quantity of fabric and to ensure uniform saturation, so that the rate of wear of the finished product does not vary throughout its whole thickness.

Saturation Processes

The fabric is passed through a dipping tank, the excess of the impregnation fluid removed with a scraper on a roll and dried in an oven at about 200 degrees C. In one process, the fabric is first dried by passing through a drying chamber at 150 degrees C., then passed through a dipping tank containing a very thin solution of an easily absorbed binder, and finally dried in a similar oven at 200 degrees C.

In another process vacuum and pressure are employed. The fabric is placed in a large jacketed pan connected with a vacuum pump. A lid is clamped down on the pan and the temperature raised to approximately 90 degrees C. After applying the vacuum, a solution of the binder is sucked in and steam or compressed air is forced in above the fluid. The pressure forces the solution into all parts of the fabric. The fabric is then removed and dried in an oven at 175 degrees C.

Yet another process, known as the drip process, is often used, in which the fabric is fed under a tank with a number of openings from which a regulated quantity of the binder drips on the fabric.

Solvents are dispensed with in another process by using the binder in powder form. The asbestos and cotton fibres as they emerge from the carding machine are sprinkled with pulverized gilsonite or resin and then wound on spools—an operation known as roving. The fibres are then woven in the usual manner and the fabric is heat treated. The binder becomes plastic and flows into the webs of the fabric. Gilsonite is hardened with the removal of heat while the resin is polymerized to infusible stage under continued heat.

In the recently developed processes, the yarn is either dipped in the binder liquid or the latter drips on the yarn, before weaving. After passing through the impregnating tanks, the yarn is dried by hot air and then woven into the fabric.

The impregnation of the yarn before weaving is decidedly an improvement on the old processes of fabric impregnation, because to saturate an asbestos fabric uniformly and to fill all the webs and crevices of the fabric is a difficult process. The binder may only surface dry or, with the evaporation of the solvent, some of the compound may come to the surface due to capillary action of the fibres. Again, if the binder is in a colloidal solution, as with gilsonite, the fabric may have as much as one-third of the binder as a surface deposit, leaving the inside of the fabric only partially filled. Such surface deposits will also be experienced with the dipped yarn, but in the subsequent weav-

ing of the yarn, these will be carried to the core of the fabric and under heat will flow to the centre of the lining.

Calendering

The next step is to calender the impregnated fabric to the required width and thickness in a heavy machine with two steam-heated rolls, one above the other and nearly touching each other. Calendering enhances the life of the brake lining considerably as it increases its density and resistance to wear. Stencilling and cutting to exact size are the final operations in the manufacture of woven linings.

Moulded Fabric Lining

Asbestos-cotton-wire woven fabric is usually employed in the manufacture of these linings. The fabric is impregnated with the binder exactly in the same manner as with woven linings, but the binder used is much less; usually 2-5 per cent. on the weight of fabric is sufficient. The idea behind this impregnation is to just waterproof the fabric and generally drying oils and bituminous materials are employed. The dried waterproofed fabric is then coated with the friction compounds on a heavy calendering machine with three steam-heated rolls. These rolls, which are one above the other and nearly touching each other, are slightly crowned to prevent bending at the middle under heavy pressure and run in opposite directions.

The friction compounds are the same materials as previously described under the heading of binders, but none of these materials is employed singly. A complex combination of three or more of these materials is common in the industry. In some cases, to produce compounds of exceptionally high friction value, abrasive materials, such as carborundum, iron oxide, sand, pulverized glass, are added. Addition of graphite, mica, waxes, and soaps generally lowers the friction value of the compounds.

The friction compound is fed in between the top and the middle rolls of the calender and meets the cloth which travels between the middle and bottom rolls. The operation is termed skimming when the middle and bottom rolls revolve at the same speed and becomes frictioning if the rolls run at a different speed. Under heavy pressure of the rolls, the friction compound is pressed into the fabric matrices, and the whole fabric is thoroughly coated with it; the thickness of the coating, of course, depends on the opening between the rolls. Skimming is a quicker process than frictioning, although the latter is probably the more generally preferred by the industry. The calendered cloth is then cut into strips of the required width and rolled on spools.

The next stage is the premoulding of the lining to the desired size and shape before curing. The friction compound on the calenders does not penetrate and thoroughly saturate the fibres of the fabric, and, consequently, an allowance of 25 per cent. in the compression of width is allowed in the uncured lining. Various methods have been developed for the premoulding of the linings, which may be briefly described as follows:—

Folding Methods

Many methods of folding have been patented, in some of which the calendered fabric is double folded or curl folded or loop folded. Sometimes one or more strips of calendered fabric are inserted in the centre of the folded fabric, so that the latter encases them. Each fold of calendered fabric is generally $\frac{1}{16}$ in. In one process, the folded lining is compressed under heat and pressure till completely cured, while in another it is first attached with wire and then heat treated. In the folded linings the folds run parallel to thickness or the wearing surfaces and the back of the lining, but in a loop-folded lining the plies are diagonal to the thickness. Yet in another process, folding on the bias is employed.

Rolling Method

According to this process, the calendered fabric is wound on a hollow mandrel having the desired curvature;

for each $\frac{1}{16}$ in. thickness of the lining one ply of the calendered fabric is employed. Heat treatment softens the frictional compound and binds together the plies of the fabric. The lining is either fully cured and then cut to size or it may be first cut into segments and then cured.

Another rolling method consists of tightly rolling up the fabric of the required width to the desired size and then curing in a cylindrical mould.

Laminating Method

Rolls of the desired width of the calendered fabric are mounted on a "laminating" machine; the number of reels or plies depends on the thickness of the lining. The plies after coating on one side with a bonding cement consisting of cellulose acetate or a rubber or some other adhesive solution, are compressed together under heavy pressure of the rolls of the laminating machine and cured finally under heat and pressure.

Lamination is also frequently carried out on the calendering machine. Two layers of the calendered fabric are passed under the hot rolls and pressed together to give a two-ply material. A three-ply lining is obtained by feeding together a single and a double ply, while a four-ply lining is made by pressing two double-ply layers. The laminated fabric is then cut to the required width and cured in a hydraulic press, when a composite, uniform material is obtained in which no signs of lamination are visible until the fabric is cut in two.

The lamination method offers a process in which different fabrics and/or different binders may be used for each ply. For example, in a three-ply lining, the top layer may be coated with a low-friction compound, the middle with a medium, and the bottom layer with a high-friction compound, so that with the wearing of the lining and its consequent decrease in thickness the gripping of the brake is not affected.

Coated-ribbon Method

The friction compound is placed inside an extruding machine and a woven fabric of the desired width is passed through it. The fabric is covered on all the four sides with the friction compound and is then moulded to size in a steam-heated press.

Moulded Fibre Linings

In this type of lining the asbestos fibres are not woven into a fabric but mixed directly with the friction compound. Both dry and wet mixings are quite commonly employed. In the dry process, the mixing is carried out in either a ball mill or by repeated sifting together of the powdered fibres with friction compounds. The powder is then moulded in a plunger-type of mould by the ordinary technique applicable to the thermosetting moulding powders.

A special machine has also been developed, in which the powder is discharged from a hopper in between the opening of two rolls, which run in opposite directions. The powder is carried on the rolls and forced through a very small opening between them, where it is compressed by the heavy pressure of the rolls and emerges out in a compact continuous strip. A reinforcing backing of wire screen is in some cases incorporated, and the lining is cut to size before or after curing in the usual manner in a hydraulic press under heat.

Wet Mixings

These, again, can be subdivided in two types; one in which volatile solvents are used and stiff, dough-like mass is obtained and the other in which the mixings are carried out in a very wet state and where generally non-volatile solvents are employed. Mixings carried out with viscous liquids of A-stage synthetic resin, containing no solvent, may also be included in the former category.

For stiff mixings, generally an enclosed "dough mixer" in which blades revolve in opposite direction is employed, while for wet mixings a "pulpbeater" similar to that used in the paper industry is required. After thorough mixing, the liquid is either filtered or centrifuged, or a papermaking machine is employed forming a thin sheet, which is dried and

laminated to the required thickness. If desired, a reinforcing backing of a wire screen is also incorporated at the stage when the sheet emerges from the paper machine and is carried by an endless belt to a steam-heated winding cylinder.

Hot Mixings

Rubber compounds and sulphur are usually mixed with the asbestos fibres on hot rolls employed in the rubber industry for compounding various ingredients with rubber. Rubber itself softens under heat and can be easily worked on hot rolls, but with the addition of fibres and other materials it stiffens considerably, and addition of lubricants, generally termed softeners, becomes necessary for easy working. Fatty acids, waxes, resins, gums, vegetable and mineral oils and tars are the most commonly employed rubber softeners in the brake lining industry.

A " Bunburry " mixer is also frequently employed for rubber mixings.

Mixing on the hot rolls is also sometimes employed with synthetic resins, but great care is necessary, due to the comparatively short life under heat of such resins.

The mixed compounds are then formed into a sheet, calendered and vulcanized, when desired, during the sheeting operations.

Rubber alone is not suitable for brake linings, but when properly compounded with asbestos, steel wool, mineral wool, cotton, flax, carbon black and zinc oxide, forms a highly useful material for brake linings.

In the linings made by the dough and hot-mixing method, the fibres lie in all directions at random, while with sheeting process they are generally parallel to each other. By cutting an uncured parallel fibre sheet into pieces of the same thickness, placing them side by side on the cut ends and curing them, a perpendicular direction is given to the fibre.

Lamination of the moulded fibre lining is occasionally employed to build up the required thickness from a thin uncured parallel fibre sheet.

Commercial vehicle developments during recent years have brought higher speeds and increased loads so that the amount of energy to be dissipated during a rapid stop of a heavy vehicle is such as to present a serious design problem. Temperatures up to 250 degrees C. of the drum may become common, and repeated braking in too frequent succession may raise the drum temperature to 400 degrees C. or more.

The normal rate of work for an ordinary brake lining is 13,200 ft./lb. per sq. in. per minute, while on the commercial lorries or buses it is considerably more and averages about 49,000 ft./lb. per sq. in. per minute. In a passenger car, the loading is limited to 10-25 lb. per sq. in., while that in buses and trucks becomes 30-300 lb. per sq. in. For such heavy-duty work, ordinary passenger car brake lining is almost useless, as it would be greatly overworked and wear out too rapidly. Specially designed linings, usually called friction blocks, are adopted for such heavy-duty work.

The woven lining is generally recommended for uses up to a temperature of 175 degrees C.; fading is experienced above this temperature, becoming pronounced with rising temperature and complete failure is observed at 250 degrees C.

Moulded fabric and fibre linings are used in those cases where great rubbing velocities, high temperature and braking pressures are met. Increased efficiency and service is obtained from die-pressing of the lining and the strength and the density is increased by about 25 per cent. compared with woven linings of similar composition. Increased pressure gives a denser and more thoroughly bonded lining, while complete curing imparts to its infusibility and the life is increased by 50 per cent. Consequently, such a lining can withstand higher temperatures and higher rubbing pressure than is possible with the woven linen.

Friction blocks are invariably made by die-pressing the impregnated fibres. The same composition as that used for the moulded fibre linings is employed, the

main difference between the two linings being that of the size and shape and the manner of arrangement of joining to the brake shoe.

Moulding Machinery

The moulded fabric linings are cured in power-operated long hydraulic presses. Presses up to 20 ft. long, known as belt presses, are used. Heating or cooling of the platens of the presses is provided. Generally steam is the motive and heating power, although in U.S.A. electricity is preferred.

Long narrow moulds are used, but pressing directly between the platens is also common, in which case steel bars of exactly the same height as the thickness of the finished lining inserted between the platens prevent the press from closing too much.

The moulded fabric lining is generally made in rolls from 100 to 200 yds. in length, and, consequently, the curing of the lining is carried out, section by section, corresponding to the length of the press, without cutting. A temperature of 150-175 degrees C. and pressure up to 3,500 lb. per sq. in. are commonly employed.

The moulded fabric lining is also supplied in small cut pieces with moulded rivet holes. In this case, as well as for moulded fibre linings, individual plunger type of moulds with single or multi impressions are used. The bottom plate of the mould has several cavities of the required shape and dimensions and is fixed to the lower platen of the press. The other part of the mould, having projections to fit in the cavities, is fixed to the upper platen of the press. The moulds are generally steam heated. For curing, a temperature of 175 degrees C. and pressure up to 5,000 lb. per sq. in. are used.

PLASTICS IN SOUTH AFRICA

By W. L. Speight, Cape Town

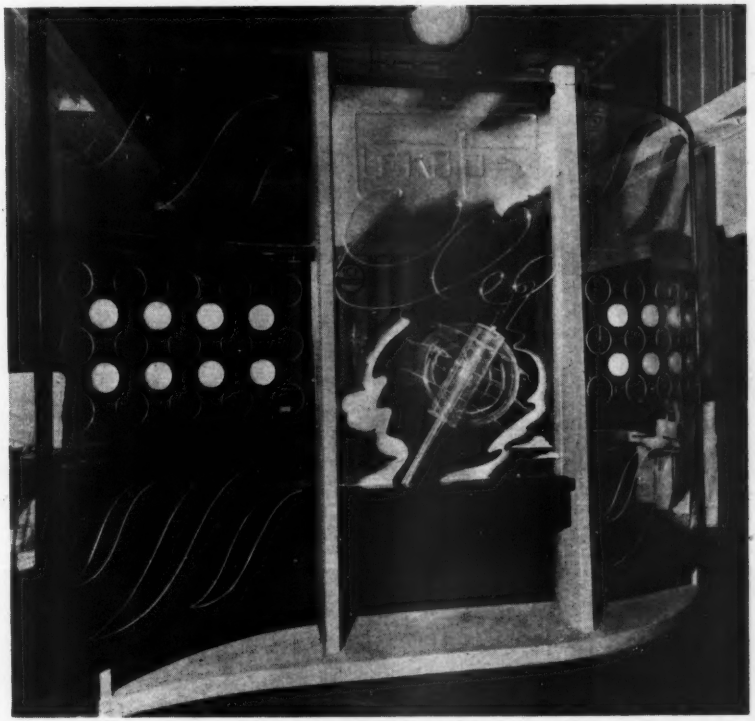
The possibility of building up in South Africa a plastics industry and a chemical industry on a large scale by the exploitation of natural gas, which is found in association with coal deposits, was discussed by Mr. Harold Wilson, of the bio-chemical laboratory, Johannesburg Health Department, in an address in Johannesburg to the South African Association for the Advancement of Science on " Methane—a Neglected National Asset."

Methane occurs in natural gas in enormous quantities in association with coal or oil deposits. Much of this natural gas has been wasted in the past, but the amount used, mainly as fuel from Great Britain's coal mines, is equivalent to 1,000,000 tons of coal a year. In the United States in 1931, 1,686,436,000,000 cubic feet of natural gas were put on the market, and vast unknown amounts were blown to waste. Comparatively little is known of the occurrence of natural gas in South Africa. " The search for natural gas ought clearly to be a national matter, and it is probable that careful study of situation of drilling sites would result in extensive supplies of natural gas from South African coal mines," he said.

At a borehole in the Witbank district about 20,000 cubic feet of gas was issuing daily. This borehole has been blowing for 20 years and more. It is possible that more than 100,000,000 cubic feet of gas have been wasted from this one borehole. Methane is now used on a large scale, chiefly as fuel for the provision of carbon black and in metallurgical processes. It has other potentialities. It has been shown that hydro cyanide, which is of especial interest to the Witwatersrand, may be produced by passing electric discharges through a mixture of methane and ammonia at low pressure. Mr. Wilson said a national survey would probably disclose extensive supplies of natural gas in South Africa, and the wide range of chemical products that could be obtained from methane, a constituent of natural gas, would make possible a large-scale chemical industry. By breaking down methane a key substance in the plastic industry — formaldehyde — could be obtained, and this, with the wide cultivation of softwood trees, could give the foundation of a plastic industry. " Important developments in South Africa might hinge on the establishment of a plastics industry here. By impregnation of softwoods or other fibrous materials with suit-

(Continued on p. 580)

"PERSPEX" IN PEACE-TIME

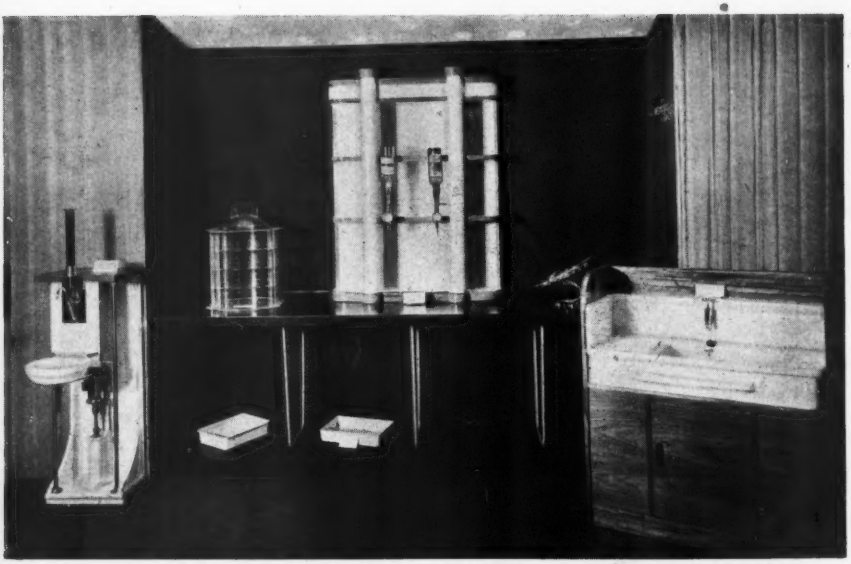


This entrance screen illustrates the facility with which the material may be worked into complicated forms and demonstrates also its striking optical properties. Side trough lighting is employed throughout.

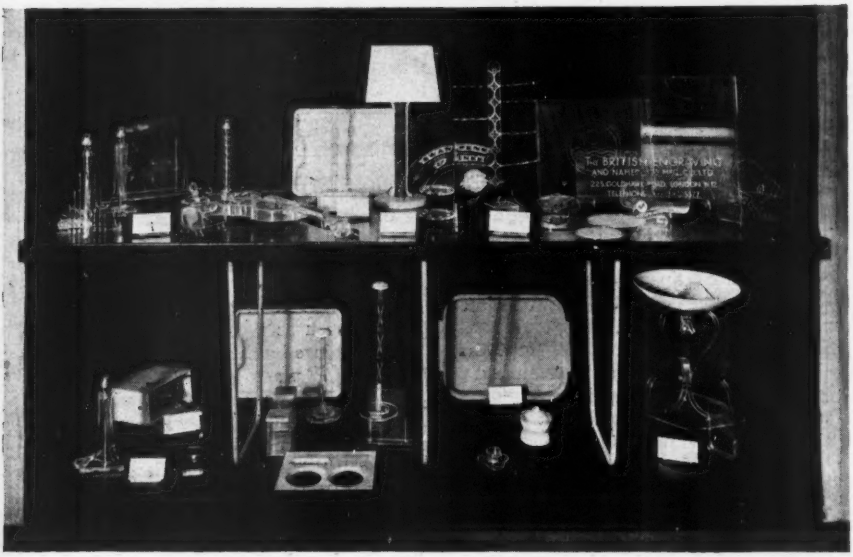
WAR requirements demanded a substantial capacity for the production of "Perspex," and, in furtherance of the swords-to-ploughshares movement, the Midland Regional Office of I.C.I. arranged in Birmingham's Chamber of Commerce, last month, an exhibition of some of the many possible peace-time applications of this material.

To most people, at any rate outside the plastics industry, "Perspex" is familiar chiefly as a transparent material, but its range of usefulness has been extended by the introduction of a translucent variety in a number of pastel colours. So far as the transparent form is concerned, the exhibition showed several new applications in addition to those already well known, such as a collection of large aircraft shapings by the Triplex Safety Glass Company, "piped" lighting instruments by Vann Bros. for surgical and veterinary use, and transparent working models by the Dunlop Rim and Wheel Co.

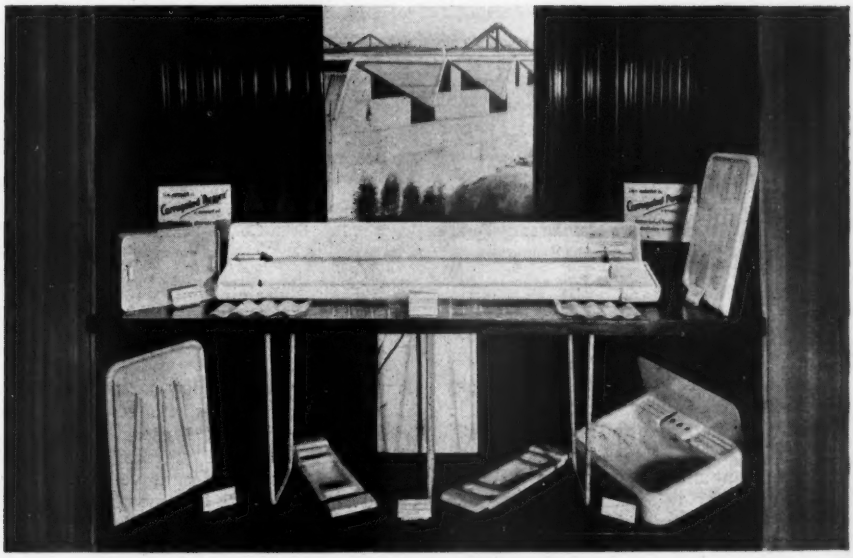
Amongst the later applications of transparent "Perspex" is the corrugated sheet in profiles and sizes that are interchangeable with a variety of standard corrugated iron and asbestos sheets. Intended primarily to admit daylight through other-



Beer engine with trough and splash plates of opal "Perspex," and to the right, sandwich cabinet, cocktail bar unit and bar sink unit.

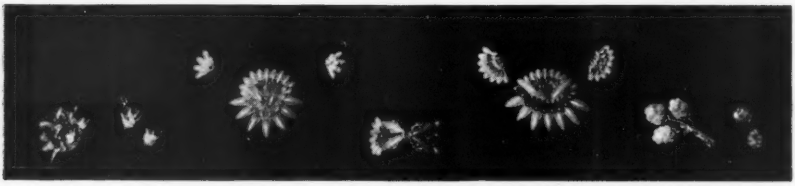


General display of trays, ornamental stands, violin, etc.



Wash basin, draining boards, bath units, lighting trough and corrugated "Perspex." This exhibit also demonstrates the pleasant pastel shades which are available.

Examples of formed transparent display stands.



Some of the lovely "jewellery" seen at the Exhibition. The above examples were fabricated from translucent "Perspex" by the Rex Gem Co., of Leicester.

wise opaque roofs and walls, this corrugated "Perspex" may also be worth investigation to replace glass in greenhouses, etc., by virtue both of the lighter structure which can support its low weight and of the fact that it is more permeable to ultra-violet rays than the normal glasses.

Transparent "Perspex" was to be seen also in a number of decorative applications (the display screen at the entrance was a very remarkable piece of work), and in such novel forms as a complete violin which was not merely playable but has already brought inquiries for the supply of substantial numbers, we understand.

With regard to the manufactured units of Vann Bros., whose work we have followed with close interest since the beginning of the war, it is noteworthy to point out that while the exhibits, which included veterinary vaginascopes, sigmoidoscopes, retractors for large cavities and diagnostic sets, were not as exciting to the public as was the equipment for the home, it should, nevertheless, be remembered that these instruments, incorporating "Perspex" as a cold light carrier, have proved of immense value in surgery. Indeed, they have enabled the carrying out of certain operations which would hardly be possible using the old type of instrument.

Turning to the translucent "Perspex" which can be manipulated and fabricated in exactly the same way as the transparent type, the applications ranged from a display of quite attractive "jewellery" and dress ornaments by the Rex Gem Co., of Leicester—displayed, of course, in a transparent "Perspex" showcase—to wash basins, draining boards and other domestic equipment by Troman Bros., of Shirley, Birmingham.

Gaskell and Chambers, Ltd., Birmingham, showed hotel equipment, including a sink unit, beer engines with troughs and splash plates in opal "Perspex," and a cocktail bar in coloured "Perspex." Opal "Perspex" provided decorative and concealed lighting effects in some of the display stands and shop fittings by Harris and Sheldon, Ltd., of Birmingham. We confidently expect this use of "Perspex" to expand considerably.

Space prevents our mentioning every item at the exhibition, but this brief account would not be complete without reference to the opal troughs (by both G.E.C. and Metropolitan-Vickers) for fluorescent lighting units.

Many of us were somewhat disappointed that the possible field of use for "Perspex" in the motorcar industry was not described in the exhibition, for most of us remember the noteworthy advantages of using the material as windscreens on a Rolls-Royce car at a Motor Show before the war (we believe about 1937). Although it was only experimental, the curved windscreen enabled the complete elimination of view-obstructing metal, and must have taken more than 50 per cent. off the weight of the normal glass screen.

Whether "Perspex" side and rear windows, with their manifest advantages of lightness and ease of curvature, which may bring improved structure, will be with us in the new motorcars remains in the laps of the gods and the kings of the industry.

The Microscopic Examination of Plastic Materials

V.—Insulating Sleevings

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

HAVING dealt with laminated materials, let us turn our attention to other plastic substances; but before continuing further it would, perhaps, be as well to state that the examinations discussed so far, and the resulting conclusions arrived at, only scratch the surface of the subject, leaving a great deal yet to be brought to light. There is still much work to be done in this field, which should unearth information of great value to the industry as a whole.

We may now, with advantage, proceed with the examination of other fabricated materials closely allied to the laminates, viz., insulating sleevings. At first sight these materials might not be considered to belong to the subject of plastics, but as the resins used in formulating the varnishes which constitute the functional medium of sleevings fabricated on a textile base are nowadays invariably synthetic, there is some justification in including these substances under the above heading, and, furthermore, many of the impregnating problems are of extreme interest to the plastics industry.

There are various types of sleevings, six of which were the subject of a previous article ("Radio Wiring Insulation," Tucker and Wredden, "Plastics," June, 1945), and it would, perhaps, be as well to reiterate these types; they are:—

(1) Varnished cotton sleeving, consisting of a tubular cotton braid treated with a linseed oil varnish.

(2) Varnished silk sleeving, which is a braided artificial silk (regenerated cellulose) treated with a varnish in a manner similar to No. 1.

(3) Braided varnished silk, consisting of an inner core of varnished natural or artificial silk rolled into tubular form, on top of which is a cotton braid covering, which may or may not be further treated.

(4) Polyvinyl acetate-treated braided silk, this being a tubular braid of regenerated cellulose, treated with a P.V.A. solution in the same manner as the varnished cotton.

(5) Polyvinyl chloride sleeving, which is a simple tube of extruded P.V.C. plasticized and pigmented.

(6) Braided P.V.C. sleeving, being the same as (5) but with the addition of a cotton or silk braid as external covering.

Before proceeding further, let us briefly examine the characteristics required of an insulating sleeving; thus we may say that:—

(1) The sleeving must possess good electrical properties under all conditions of service.

(2) It should have negligible moisture-absorbing qualities in order that its electrical properties may not be unduly impaired when working under adverse conditions of humidity and temperature.

(3) It should be stable to heat, under which heading must be included the stability of dyes and pigments used for colouring.

(4) It must not become brittle at temperatures in the region of −40 degrees C.

(5) It must be flexible and capable of being easily bent without reduction of its electrical and physical properties.

(6) It should possess high solvent resistance, so that it will be capable of withstanding impregnating processes, particularly in the case of varnishes.

We have seen from the section on laminates how the structure influences the moisture absorption, and in the previously mentioned article, figures for moisture absorption of these sleevings were given. These are reproduced in Table 1. The sleevings numbered 1 to 4 are all fabric-based products of one sort or another, the letter suffixes denoting different manufacturers. From these figures it will be seen that all the fabric-based sleevings possess very high moisture-absorbing properties. Comparison with an extruded P.V.C.

Table 1.

Sample Class No.	Moisture Absorption % wt. (average of three specimens)
1a	4.23
1b	2.016
1c	9.76
1d	3.88
2	18.5
3a	6.93
3b	5.35
3c	7.26
3d	6.32
4a	10.64
4b	9.87
5	0.26
6	2.57

sleeving (5) shows how poor these materials really are from the electrical standpoint.

Of all the physical properties, that of moisture absorption is perhaps the one whose resultant effect on the electrical properties of a material is most pronounced, although the presence of relatively large volumes of occluded air must not be overlooked, in spite of the fact that this latter does not exert its greatest influence until ionizing voltages are encountered. Let us, therefore, examine the structure of these materials with these factors in view.

We may begin by examining the structure of the Class 1 sleeving, that is the conventional varnished cotton braid. In Fig. 34 we have a transverse section of a typical varnished cotton sleeving, photographed at 50 diameters. This structure may be taken as being broadly representative of this class of material, and we see from Table 1 that the moisture absorption of these sleevings varies from manufacturer to manufacturer. For example, 1b has a moisture absorption of 2.016 per cent., while for 1c it is as high as 9.76. This we will see is due to variations of processing methods and of the base materials used; nevertheless, Fig. 34 may be said to represent the class as a whole.

We see from this illustration that the cotton braid has been coated with three layers of varnish, the interfaces of the varnish films are indicated at A, B and

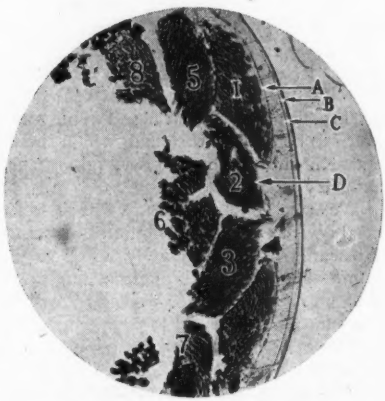


Fig. 34.—Transverse section of conventional varnished cotton sleeving showing poor penetration into the substance of the cotton braid. (Magnification: 50 diameters.)

C, but it will be readily appreciated that the varnish has scarcely penetrated the cotton yarn at all, although it appears to have penetrated to a reasonable depth, as indicated at D. This is more probably due to the varnish sinking into the interstices of the weave, as the upper surface of the bundle at D is below that of the bundle immediately above it. Thus one would be led to assume deeper penetration than really exists, if the fact that the penetration into the actual interstices of each thread of yarn is the factor that should be sought after is overlooked.

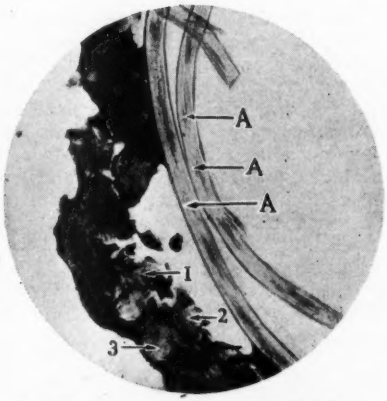


Fig. 35.—Transverse section of braided rolled, oiled silk sleeving, showing open structure in general (Magnification: 48 diameters.)

As can be seen from this illustration, the penetration of the varnish into the yarn itself is negligible. Thus we can say that in the bundles numbered 1, 2, 3 and 4 the varnish has penetrated very slightly, but bundles 5, 6, 7 and 8 are entirely without any varnish in their structure. Likewise the channels between the bundles are free from varnish. In general, therefore, the structure of the Group 1 sleevings may be considered to consist of cotton braid with a relatively thin external film of varnish, although, as we shall see, some are better than others, so far as penetration of varnish is concerned.

Let us now consider the structure of Group 3, which consists of a tube of rolled varnished natural silk covered with an external sheath of cotton braid, which may or may not be treated with varnish or lacquer. Fig. 35 is a photomicrograph of a transverse section of such a sleeving photographed at 50 diameters. The general features, such as the double roll of varnished silk and the cotton braid in section, are quite easily distinguished, and it will be seen that the braid has also been treated. The two structures in this material illustrate the undesirable characteristics of faulty impregnation on the one hand, and the eminently satisfactory condition of almost complete impregnation on the other, this latter existing in the natural silk. It will be seen that the silk fibres (A) are completely embedded in a solid matrix of varnish, forming a homogeneous product. The braid covering, on the other hand, illustrates just the opposite condition. In this case

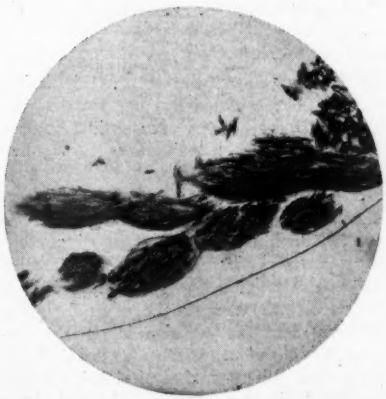


Fig. 36.—Longitudinal section of varnished cotton braid sleeving. (Magnification: 50 diameters.)

Fig. 37.—Longitudinal section of braided, rolled, varnished silk sleeving. (Magnification: 50 diameters.)

it is treated with a pigmented lacquer, presumably to hold the braid together and to afford a means of producing the material in distinctive colours. The textile base is, of course, not impregnated at all, as shown by the bundles 1, 2 and 3, and the general form and structure of this braid would not appear to be conducive to close dimensional tolerances. We shall discuss this structure in greater detail subsequently, but it may be taken as representative of the Group 3 materials.

These two structures are very much the same when seen in longitudinal section, as shown in Figs. 36 and 37, the former being a longitudinal section of the same material as illustrated in Fig. 34, while the latter is a longitudinal section of the material shown in Fig. 35. Both these photomicrographs are taken at a magnification of 50 diameters; in general, the structures are similar to those shown by transverse section. In the former case, the depth of the varnish film is perhaps a little more clearly shown, due to the lower layer of the braid having become slightly dislodged. In the braided varnished silk (Fig. 37) a clearer picture of the relative positions of the silk and the braid is seen, and the behaviour of the lacquer used on the braid is also shown. Taken together, these four illustrations serve as a good guide to the type of structure possessed by the materials in Groups 1 and 3. With the exception of Groups 5 and 6, the structure of the remaining groups may be taken as being similar with regard to the textile base.

We may now examine the Group 1 materials in greater detail. Sections of these sleevings photographed at 50 diameters are shown in Figs. 38-41; each of these materials is produced by a different manufacturer, but are of the same general type. If we examine the first (1A) we see that the braid is double, being composed of four distinct layers of cotton, the whole has been treated with three coats of varnish. The first coat has penetrated the interstices of the braid only partially, three large voids being evident at A, B and C. Bubbles in the varnish matrix are shown at D, E and F, and in all probability are due to the presence of solvent vapour and air trapped during the drying operation. It would appear that the voids, as distinct from the bubbles, are caused either by a too vigorous drying operation, resulting in excessive shrinking, or poor penetration of the varnish which would result in the entrapping of formidable masses of air in the structure of the braid. It will be noticed that the varnish has by no means penetrated

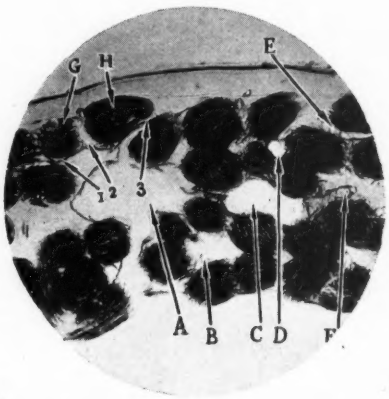


Fig. 38.—Transverse section of varnished cotton sleeving No. 1A. (Magnification: 50 diameters.)

the interstices of the yarn, this being clearly demonstrated by the fact that the high shrinkage of the varnish in this particular case has been sufficient to cause the occurrence of a gap between the surface of individual yarns and the matrix. This phenomenon is rather difficult to see in the illustration, but two instances are shown occurring round the bundles of yarn marked G and H at the points 1, 2 and 3. A large gap between the yarn surfaces and the varnish is clearly distinguishable at 2. It may be pointed out here that whereas the photomicrograph does not show a great number of these gaps at all clearly, a careful visual study of the section reveals them to be present in the great majority of cases.

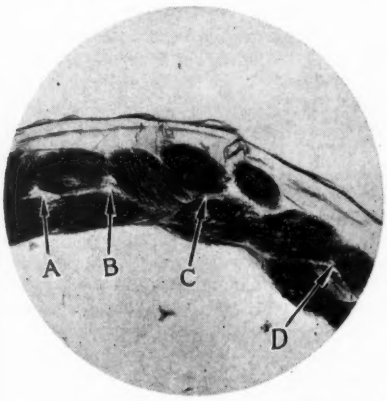


Fig. 39.—Transverse section of varnished cotton sleeving 1b. (Magnification: 50 diameters.)

This phenomenon is proof enough of the unimpregnated condition of the yarn, and it would appear that no advantage is gained by the use of a double thickness of braid; on the contrary, one would be quite justified in assuming that definite disadvantages accrue as a result of the use of this particular type of base, for, as we shall presently see, the double braid is particularly prone to give rise to the undesirable features just mentioned. This is naturally due to the added difficulties encountered in applying the varnish, for we have seen in our study of laminated materials that the ideal condition is realized when each cotton fibre is filled and entirely surrounded by a continuous matrix of binding material, be it resin or varnish, apart from which the matrix itself must be quite homogeneous and entirely free from inclusions such as bubbles of vapour or voids of any kind. From this it will be appreciated that here again a completely homogeneous structure is indicated for obtaining the best results.

Let us now proceed to the other members of the group. Fig. 39 illustrates the second sleeving 1b, photographed at 50 diameters. This material is a single braid consisting of two layers of yarn interwoven with one another. The braid is fairly tightly woven, which is another factor operating against good penetration of the varnish; however, the fact of its being a single braid, instead of double, tends to produce a better product. The absence of large voids encountered in the first type are noticeable and, at first glance, this material might appear to be close to the ideal structure, but a more careful examination shows the presence of a number of small voids at A, B, C and D.

The noteworthy feature here is the location of these voids, which occur on what might be considered the centre line of the yarn, from which it would appear that the first coat of varnish applied to both surfaces of the braid fails to penetrate sufficiently through the material; on the other hand, the initial coat of varnish might be applied on the outer surface of the braid, which is stretched on to a mandrill, in which case the varnish has penetrated through the thickness of the textile base, but only in those places where the weave was relatively open and by a process of flowing round the yarn. So that at points where the layers of yarn are most tightly packed on a plane coincident with the centre line of the braid (as shown in the illustration) the occurrence

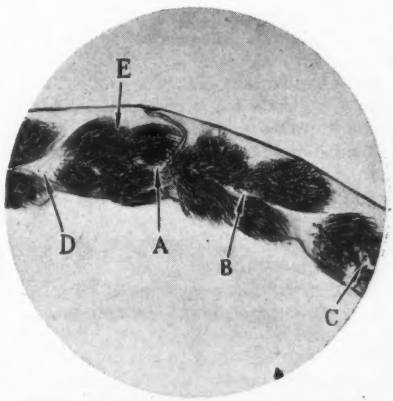


Fig. 40.—Transverse section of varnished cotton sleeving 1c. (Magnification: 50 diameters.)

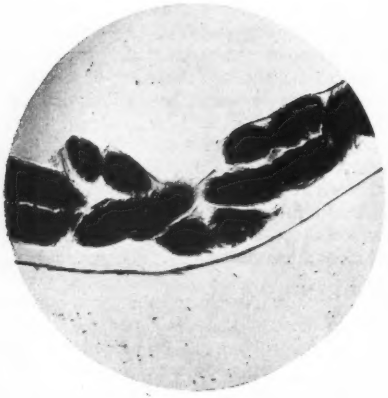


Fig. 41.—Transverse section of varnished cotton sleeving 1D. (Magnification: 50 diameters.)

of voids is to be expected, rather than otherwise. This example also shows the braid to be unimpregnated; in fact, it is difficult to visualize how this type of sleeving could possibly be completely impregnated and produced in reasonable conformity to the concepts of the ideal structure already suggested, without taking extraordinary precautions as to the removal of air and other injurious foreign matter from the interstices of the yarn itself. However, in general, this material shows the advantage gained in using a single braid, but we should not overlook the disadvantage encountered in the use of a tight weave, which latter assumption is really quite logical when it is considered that the varnish is expected to find its own way into the material.

It will be seen that the varnish has been applied in three coats, the first occupying the thickness of the braid, while the second two appear to lie on the outer surface of the sleeving. This would tend to support the aforementioned suggestion that the varnish is applied to braid which is threaded on to a mandrel.

Proceeding to the next type of material, namely, 1c, illustrated in Fig. 40 (magnified 50 diameters), we see a condition similar to that shown in Fig. 39, but in this case the braid would appear to be much more loosely woven, the immediate result of which is to allow much better penetration of the varnish. This is apparent by the smaller size of the voids present at A, B and C (again on the centre line), which are only just discernible. Furthermore, this material has had three coats of varnish applied to it in the same way as that previously mentioned, but it will be noticed that the outer two coats occupy considerably less of the total thickness than in the previous case; in fact, the braid at one point is almost coincident with the outer surface of the material. The solid masses of varnish at points similar to E should be noted as affording evidence of improved penetration, whilst further evidence of better penetration into the interstices of the yarn is shown by examination of the peripheral areas of the bundles (F), where an area more transparent than the centre of the bundle will be noticed. This increase in transparency is due to the occurrence of a more uniform refractive index at such places, for it has previously been pointed out that if a cotton fibre were immersed in a medium of the same refractive index as itself, then it would become invisible. The sleeving illustrated in Fig. 41 (at 50 diameters) (1d) is similar to both 1b and 1c, although in this case the yarn is dyed red, which accounts for its dark tone in the photograph. Structurally, this material may be placed midway between 1b and 1c, the weave being fairly tight, i.e., not as tight as that found in 1b, but tighter than that of 1c; the size and number of voids are midway between 1b and 1c, the same applying, of course, to the degree of penetration of the varnish into the yarn. The interiors of the bundles, however, are still unimpregnated.

The foregoing remarks regarding the resistance to penetration of the varnish by the type of base material only approach the problem from considerations of the structure of the sleevings, and whereas the points enumerated do seem to suggest various methods by which the problem

may be overcome, they do not by any means constitute all the factors which are liable to affect penetration. The question, when looked at as a whole, would appear to be so complex as to afford very little hope of any easy solution. Therefore, at this stage it is proposed to examine the question of penetration of the varnish from the broadest possible viewpoint, taking into consideration as many as possible of the operative factors adversely affecting the production of a completely homogeneous product.

Suppose we examine the characteristics of the basic materials used. First, we have the cotton braid woven from yarn, and in order to facilitate the braiding of the cotton it is customary to dress it with various substances, such as starch and gluten mixtures. We then come to a consideration of the varnish, which is usually based on a drying oil which may or may not have resins incorporated to act as a toughening medium, the whole being thinned down with a solvent to bring its viscosity within workable limits.

The electrical characteristics of these varnishes in the dry condition are, as a rule, very good, and if we look upon the complete sleeving as a film of varnish supported and strengthened by the braid, then it will be apparent that, whereas cotton affords a good supporting medium for the varnish, it is doubtful whether any extra strength gained is of advantage, as the resultant electrical characteristics are so much poorer than those of the varnish alone. We see, therefore, that once again a base material of solid continuous fibres is indicated to maintain a condition where each filament of the textile base is embedded in a continuous matrix.

The process for applying the varnish would appear to consist of dipping the textile into it and hardening off by stoving. This leaves the varnish to find its own way into the base material, and a little consideration of the process will show that there are a number of factors capable of influencing penetration and also capable of exerting an influence on one another. The resultant mechanism is complex, to say the least of it.

In considering these factors, let us commence with the surface tension of the varnish. It is obvious that as the varnish has to find its own way into the fabric, its surface tension or wetting properties are destined to play an important part in the process. This point alone is not as simple as it appears at first sight, because the surface tension will vary according to the surfaces met with; e.g., the interfacial tension between cellulose and varnish will be different from that between varnish and air, and would be different again when the interface occurs between varnish and water, either absorbed or adsorbed, by the cellulose. Also, the tension between the dressing materials and the varnish should not be overlooked. It is clear, however, that the surface tension must be as low as possible in order to produce a maximum wetting effect.

The next point to consider is viscosity. In the case of unthinned varnishes containing resins, the viscosity is unusually high, but it does not follow that the surface tension will also be high. At the same time, it appears that the reduction of viscosity which occurs initially on heating, leads to a drop in surface tension; similarly reducing the viscosity by thinning also reduces the surface tension. As the oils used in these varnishes dry by oxidation and polymerization, the viscosity is affected by the speed of these reactions, i.e., as the drying proceeds the viscosity rises.

This brings us to the next point, which is the effect of temperature. It is clear that the rates of oxidation and polymerization are dependent on the temperature at which the drying is carried out.

Suppose we now examine these three factors relative to one another and their effects on producing a homogeneous material. We have seen that surface tension must be kept low in order to secure maximum penetration at the commencement, but when we consider the effect produced on the surface tension by heat, the problem is involved because the initial effect is to lower the surface tension and viscosity. This would appear to be to our benefit, but it must also be borne

in mind that the heat will also cause the volatile constituents of the varnish to evaporate, which immediately raises the surface tension and viscosity. Thus, as a result of heating, we have to take into consideration the variation of surface tension and viscosity consequent upon the decrease of volatile content.

Whether the rise in surface tension and viscosity is rapid or not will depend on (1) the percentage of volatile matter contained in the varnish (thus, if there is only a small percentage of volatile matter present, the increase of surface tension would be expected to be small, but the increase of viscosity could, quite conceivably, be considerable); (2) the vapour tension of the volatile component, the rate of evaporation being high or low according to whether the vapour tension is high or low. Thus, if there were a small percentage of volatile matter it would appear possible to have a set of conditions wherein the surface tension is comparatively low at the commencement, but after a short time at the stoving temperature it will rise considerably, due to the rapid removal of the volatile matter, as a result of which the varnish will suffer degradation of its wetting properties, and any masses of air trapped initially will tend to be held in place. It would appear, therefore, that there must of necessity be an optimum value for the percentage of volatile matter in the varnish, together with a similar value for the vapour tension of this latter, which involves a careful selection of the thinners and a correct choice of its proportion.

The foregoing remarks have ignored the rise in viscosity due to stoving; this, of course, is due to the evaporation of the volatile matter and the onset of oxidation and polymerization. The rate at which this rise occurs is due to and varying with the rate of removal of thinners, the rate of increase of temperature and the amount of air circulating in the drying chamber. Obviously, a too rapid rise in viscosity resulting from one or all the foregoing factors coming into operation is to be avoided, as this would add considerably to the tendency for the rise in surface tension to trap and hold any air or gases in place, added to which the liability of causing excessive shrinkage in the dried varnish should be examined.

Let us examine the effect of variation of viscosity, etc., by taking a hypothetical case in which we use a pure oil without any thinners or added resins and possessing a very low surface tension at ambient temperature. This would give us a set of conditions calculated to be the least likely to cause failure, thus the surface tension should drop initially until such time as the temperature had risen sufficiently to bring about the onset of the drying reactions. When this occurs the viscosity commences to rise accompanied by a rise in surface tension, and if it so happens that this point has been reached too rapidly, the release at the surface of the more deeply situated bubbles will immediately be hindered, in consequence of which the oil will solidify with the bubbles in situ; also as the penetration of the varnish is taking place all the time, this will be considerably impeded if not stopped completely.

Still considering our hypothetical case; if it were so arranged that the rate of rise in temperature was sufficiently slow to allow any trapped bubbles to come to the surface and escape before the viscosity reached a limiting value, then the low surface tension would help considerably, but if the temperature were increased rapidly then the help given by the low surface tension would be negated by the rise in viscosity being too rapid. This would also tend to produce other bubbles due to gaseous products of the drying reactions being liberated more rapidly, the removal of which would be restricted by the rapid rise in viscosity and the solid film formed prematurely on the outer surface.

All this would apparently occur as a result of only the three aforementioned factors coming into operation, and in a case chosen to facilitate matters so far as possible. We have so far ignored, or rather assumed that the condition of the yarn was such as to cause no hindrance to the impregnation, but a little thought on the matter soon shows that such factors as the twist in the yarn and the weaving tension will all add their quota, not for-

getting such characteristics as the weight of the yarn and the nature of the fibre or filament used, together with the various substances used as size or lubricant.

Thus on summing up these factors, we may say that they affect the impregnating process adversely if they are not controlled, such control being exercised in relation to the desired product as a whole, and also in relation to one another. They may be tabulated as follows:—

(1) Surface tension of solution.

(2) Viscosity of solution.

(3) Vapour tension of solvent. Effect on:—

(a) Surface tension.

(b) Viscosity.

(4) Rate of increase of temperature. Effect on 1, 2 and 3, and removal of solvent.

(5) Drying actions. Variation with and effect on temperature change, surface tension and viscosity.

(6) Condition of yarn prior to use.

When it is realized that all the numerous variable factors just named are capable of a certain amount of control, and bearing in mind the interdependence of their functions one with the other, the problem appears to be truly formidable, and indeed the manufacturers are to be congratulated on doing as well as they have, and it is again suggested that the short staple fibre yarn is unsuitable for this type of material, when a homogeneous product is desired with good electrical properties. As the solid continuous fibres are capable of producing better results if due care is taken to ensure impregnation, it would appear that they are the more desirable.

It is not by any means suggested that the aforementioned operative factors are all those involved in the problem, but rather do they merely open the subject, and are discussed in the hope that they may be of some slight help to those wishing to investigate the question in greater detail.

Having examined the structures of these cotton-based sleevings, let us look at them in relation to their moisture absorption. It will be seen from Table 4 that the sample 1a has a moisture absorption of 4.231 per cent. This would be expected owing to the double thickness of yarn and the voids present; although one might expect a figure somewhat in excess of this it must be borne in mind that the yarn and weaving are tight, in consequence of which absorption due to capillary attraction into the dry yarn would be hindered. This is supported to some extent by sample 1b, where we have a tight weave of single thickness but with smaller and fewer voids, giving a moisture absorption of 2.021 per cent.

The effects of capillary attraction are well shown by sample 1c, with a moisture absorption as high as 9.76 per cent. in spite of there being fewer and smaller voids than in either of the two previous specimens. In this case the impregnation is also better, but the heart of the yarn is still dry and being in a loose condition the capillary attraction can come into operation much more forcibly. These examples, of course, show the desirability of complete impregnation and the need for taking the interaction of the variable factors into account in the process. The sample 1d, being more or less intermediate between 1b and 1c, the moisture absorption of 3.88 is to be expected.

It would perhaps be as well to point out again that these four samples were made by different manufacturers, and the way the results agree with the structure would appear to suggest that the processing in each case was basically the same, individual modifications tending to produce products of varying quality according to whether they are modified in the right direction or otherwise. However, in general it may be stated that, for the purposes for which these materials are designed and used, their moisture absorption is too high, this of course reflecting on their electrical characteristics so as to leave little doubt as to the result of subjecting them to maintained electrical stress of any great magnitude, particularly where atmospheric conditions are adverse.

(To be continued.)

Plastics (with Aluminium) in Building

Reviewing a Recent Exhibition Featuring the Systematic Use of Plastics and Light Metals Combined to Fulfil Functional and Decorative Purposes

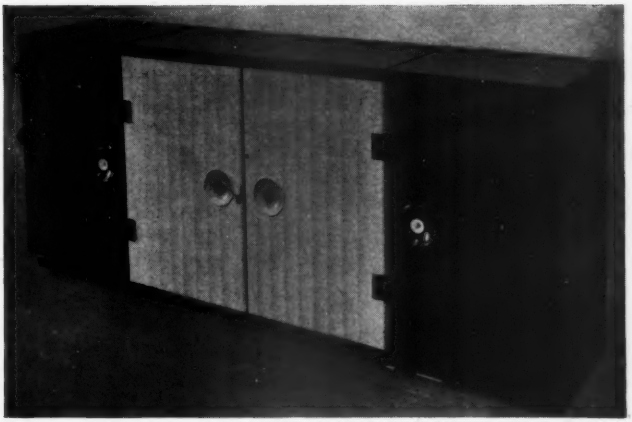
Illustrated at the right is an occasional table, consisting of a moulded plastic top mounted on a light tubular frame of pleasing design. Shown below is a view of the underside of the moulded top, the dimensions of which are standardized so that it may be employed at will for tables of various designs as well as for the top of various types of cupboard, as shown in later illustrations.

AS a result of extensive production and working experience during the war years, the plastics industry is, as is well known, now in a position to fulfil demands covering the widest possible range of industries. For economic and scientific reasons, interest centres, at the moment, very largely on the building trades, and at a private exhibition held recently at No. 3, Vere Street, London, W.1, by Runcolite, Ltd., and Industrial Plastics, Ltd., exhibits were staged demonstrating not only the potentialities of plastics themselves but, furthermore, illustrating practical and practicable combinations of these organic materials in conjunction with light metals; each was shown employed in a manner best suited to its own range of properties. As most constructors will realize, these vary widely both in the purely physical as well as in the mechanical senses.

The exhibition, which was designed by Mrs. Schreiber, included examples of plastics applicable to many branches of the building industry, from kitchen ware and cupboard units to building components. "Alpla" partition walls and bathroom fittings shows a sprayed plastic combined with aluminium.

Whilst giving special emphasis to the

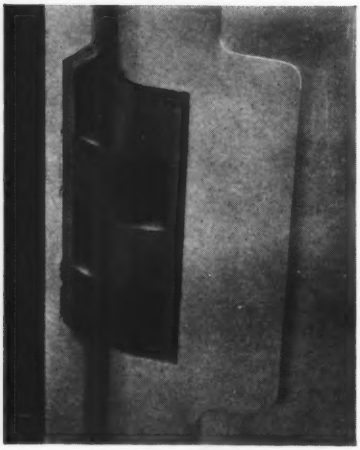
Shown at the right is a complete view of the exterior of the all-plastic cupboard, closer details of the construction of which are shown on the following page. Reproduced below is an illustration of a plastoglaze-finished light metal cupboard and drawer set, with moulded plastic handles and a top consisting of two of the standard moulded units.



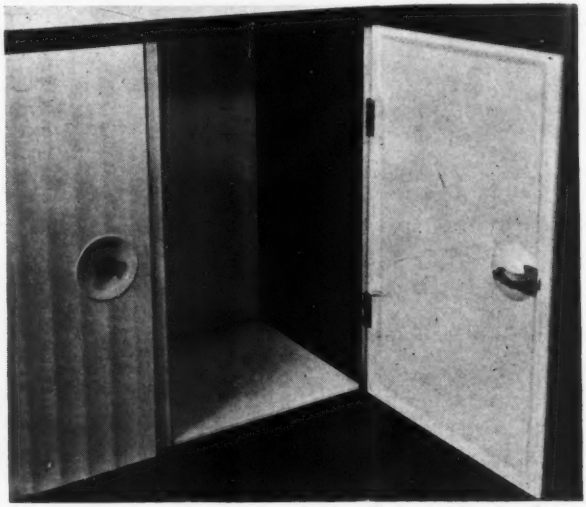
importance of plastics in relation to the housing shortage, the new materials shown are no less applicable to the post-war plans of the shipbuilding industry and the railways. Prefabricated partition walls are ideal both for the conversion of war-time transport into passenger liners, and for the construction of new railway coaches.

Colour was one of the outstanding features of the Exhibition. Every plastic product shown, whether a cupboard unit or a kitchen utensil, was designed to achieve perfect harmony of line and colour. Those interested in the surface treatment of light metals found here the answer to many problems not only as regards the use of plastics for corrosion protection, but also for purely decorative purposes. The new Plastoglaze finish and both stoving and air-drying Cerrux finishes (Cellon, Ltd.) were used.

The exhibitors represented several of the foremost firms in the aluminium and plastics industry. It was their aim to prove that Britain can attain to world supremacy in the manufacture of plastic and aluminium products. In the development of plastics and the treatment of the raw material British chemists have always had the lead, but until recent years designers possessed of originality and creative ability have been lacking. It is believed that not only was the way paved to the wider knowledge of plastics and aluminium in general, but that the new technique will find many followers.



building industry, for the advantages of aluminium alloy, with its valuable qualities of strength and lightness of weight, are rendered still more effective by a coating of plastic skin, giving durability and perfect surface finish. The use of a plastic - base finish — " Plastoglaze," originally suggested to the Admiralty as a means of speeding up the construction of M.T.Bs. and M.G.Bs., has now been applied with equal success to building. When employed for walls and kitchens it not only renders the surface resistant to rain, heat and humidity, but permits it to be washed at frequent intervals, thus avoiding the necessity of repainting. This plastic finish will shortly be available with the addition of D.D.T., the fly-killer and vermin-destroying powder which has



Pictured at the right is the interior view of a domestic cupboard, the main structure of which consists entirely of plastic mouldings. The assembly being actually built up from individually moulded components. The standard top as shown in the first illustration is here used, whilst the construction of the doors is especially noteworthy. The massive and very serviceable hinge is illustrated in a close-up view above.

The future of Britain's plastic industry is vital to her export trade, and, therefore, the articles included in the Exhibition were designed not only to meet the requirements of the home trade but also for the overseas market which is still only partially developed.

The combination of aluminium and plastic known as " Alpla " would seem ideally adapted to the requirements of the proved such a boon to our Forces in the Far East.

Plastics in kitchen furniture and kitchen ware formed, naturally, a prominent part of the demonstration; the former offers great appeal on account of its qualities of durability and lightness, coupled with the fact that such items as tables and trays are easy to handle and are non-staining. Plastic bowls and colanders

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I.C.I. manufacture the following plastics :

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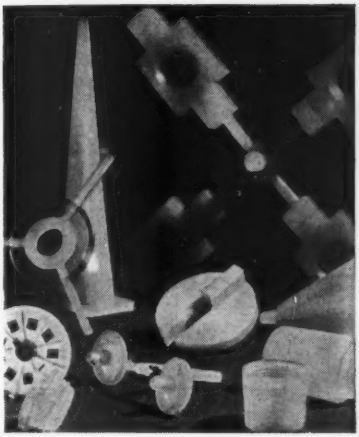
Nylon

Polyvinyl Chloride

Urea Formaldehyde

Phenol Formaldehyde

Moulders and manufacturers are invited to discuss their plastics problems with I.C.I. Technical and Research staff whose services are freely available.



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Polythene, on account of its excellent dielectric properties at ultra high frequencies, was used with outstanding success in Radar components throughout the war. Polythene is light, tough and flexible. It is water-resistant and will withstand immersion in boiling water. All these properties combine to render it an excellent material for injection moulding. "Alkathene" is the trade name for the I.C.I. brand of polythene which is produced in natural or coloured granules.

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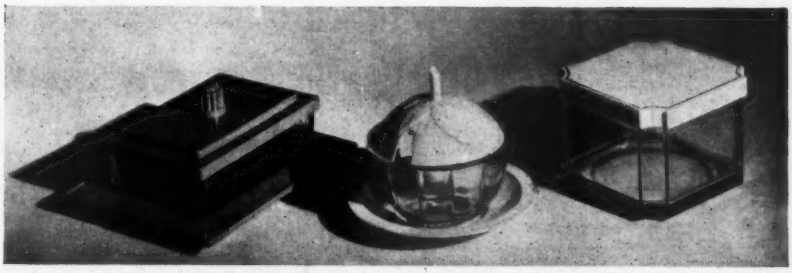
Reproduced here, at the left, is a view of the rear of the moulded door for the all-plastic cupboard. Note particularly the substantial hinging arrangements and locking devices. A close-up view of this latter is presented above.

again are pleasant to the touch, and may be supplied in a number of colours to harmonize with the decorative scheme of a kitchen. They are less readily broken than pottery or glass, can be designed to fancy shapes and, again, are open to the widest possible variety in design.

Mention might be made here of the large range of door furniture and cabinet fittings which have been prepared for mass production.

The research department of the British Artificial Resin Co., Ltd., under the direction of Dr. V. Yarsley, has developed building board proved to possess good resistance to moisture and fire hazard, and which can be manufactured with paper veneer and aluminium facing; a skin of "Plastoglaze" renders such board suitable for use in kitchens and bathrooms. The outstanding advantage of the material is its cheapness and suitability for large-scale production from readily available by-products.



Illustrating part of the large range of small general items which may, with great effect, be produced as plastic mouldings and used in combination with other materials, such as light metal and glass, as adjuncts in domestic furnishing.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

FORTICEL, a new cellulose plastic, is announced by Celanese Plastics Corporation, of America, through Reuters.

Cellulose propionate, from which Forticel is made, had been a laboratory plastic for many years, but it was only recently that a method of producing propionic acid from natural gases in commercial quantities and reasonable prices was developed. Present production is on a pilot-plant scale, but the company anticipated a steady moderate production of Forticel early next year, to be followed by large-scale production in 1947.

As a thermoplastic, the most economical and satisfactory process for making Forticel into finished articles is by injection and extrusion moulding, the company states. Finished products, display unusual surface lustre and brilliant mould finish without mechanical polishing. Furthermore, the moulding cycle can frequently be reduced with Forticel, this saving in certain instances being equivalent to a 25 per cent. gain in production.

Other scientific tests have shown that Forticel has a greater strength in the weld than any of the present commercial cellulose esters. The plastic can be printed and lacquered without fear of tackiness, and takes any colour or can be produced mottled or with intricate designs. Specific gravity is stated to be about 1.2.

I.C.I. PLASTICS AT FLEETWOOD.—The Plastics Division of I.C.I. have leased some buildings at the Hillhouse Ministry of Supply factory near Fleetwood, in Lancashire, where they intend to manufacture plastics.

Work is now proceeding on the necessary alterations to the buildings, and the installation of machinery. Owing to the difficulty of obtaining new machinery under existing conditions, the installation will take some time, but limited production will start in the next month or two. It is expected that full production will be reached in about 18 months' time, giving employment to about 300 workers.

The products to be made are nylon monofilaments, used in the manufacture of brushes, particularly of tooth brushes and other toilet brushes, and various products based on polyvinyl chloride and polythene. The manufacture of polyvinyl chloride was started in this country during the war, and hitherto this plastic has been mainly used for war purposes. Imperial Chemical Industries are now busily engaged in finding peace-time uses for it. Polythene is a plastic material discovered by I.C.I. immediately prior to the war, and so far, like polyvinyl chloride, has been used mainly for war needs. It is an extremely good electric insulating material, especially for use with the very high-frequencies used in radiolocation work. It can, however, be produced in many attractive forms, which should find a place in post-war markets.

PLASTICS IN SOUTH AFRICA.—The British Industrial Plastics Group of Companies has decided to make a detailed investigation of the market in South Africa, in the belief that there is considerable scope for the development of plastics in the Union of South Africa and adjacent territories.

With this object, Major-General A. R. Selby, C.B., C.B.E., is returning to the Union shortly, as a special representative of the B.I.P. group.

General Selby will discuss with prominent South African industrialists the ways in which B.I.P.'s products and technical knowledge of plastics can assist South African industry in developments designed to meet the particular needs and conditions obtaining in South Africa.

HALEX, LTD., announce that Mr. L. E. Room will join them as Sales Director as soon as he is released from his present duties as Director of Campaigns Division at the Ministry of Information. Members of I.S.M.A. and of the Institute of Export will remember Mr. Room when in pre-war days he was a director of F. C. Pritchard Wood and Partners, Ltd. Previously, he had spent four years in Berlin as General Manager of Eno's Fruit Salt GmbH, after considerable experience, especially on the export side, in the Sales and Advertising Departments of J. C. Eno, Ltd

R. W. GREEFF AND CO. inform us that they have now vacated the war-time office at Bishop's Stortford and have returned to the City office, Thames House, Queen Street Place, London, E.C.4.

B.I.P. THANKSGIVING WEEK EXHIBITION.—British Industrial Plastics, Ltd., was among the local manufacturers who were invited to exhibit their war-time products during the Oldbury Thanksgiving Week, which took place from October 13 to 20. Great interest was shown in the Exhibition, which was opened by the Mayor of Oldbury.

The B.I.P. stand at this exhibition was arranged in three sections—mouldstuffs and mouldings, aminoplastic cements and their uses, and resins for coatings and textile treatment.

The moulding section showed samples of Beetle urea and melamine mouldstuffs, and mouldings made therefrom such as lampshades, buttons, mess trays and aircraft insulation parts; a group of phenolic mouldings by the Streetly Manufacturing Co. included aircraft and radar components, sticky bombs, grenades, break-up shot, etc.

Beetle cements and hardeners, with their applications, comprised the second section. Exhibits included airscrew blades, aircraft wing-tips, laminated cleats for motor torpedo boats, and wall and ceiling panels for the Arcon prefabricated house. The manufacture of the Mosquito was illustrated by photographs showing the various stages of construction.

The Beetle resins section showed liquid and powdered resins, together with such applications as the lacquering of wood, tin, asbestos and fibreboard.

B.I.P. TOOLS.—During the war the tool and mould-making business of British Industrial Plastics, of Tyburn Road, Erdington, has greatly expanded and has now become a separate wholly-owned subsidiary under the name B.I.P. Tools.

CORNELIUS CHEMICAL CO., LTD., announce that Mr. W. F. Martin, manager of liquid resins department of Catalin, Ltd., has now joined the company as sales manager and technical representative.

DISTILLERS CO., LTD., has offered a grant of £500 per annum for three years to enable one or more students to undertake a course of work in the field of polymerization.

SHELLAC.—The Ministry of Supply announce that the embargo on the re-export of certain grades has been withdrawn.

THE BRITISH XYLONITE CO. announce that Mr. Charles Coubrough, managing director, has relinquished the post of managing director of B.X. Plastics Ltd., which he held for the past five years during the absence of Mr. Laurence Merriam, who has now been released from his post as Plastics Controller by the Ministry of Supply. Mr. Laurence Merriam has been reappointed managing director of B.X. Plastics Ltd.

NEW COMPANIES—COMPANY RESULTS

GRANTHAM PLASTICS, LTD.—Private company. Registered October 17. Capital £1,000 in 1,000 shares of £1 each. Objects: To carry on the business of mechanical, electrical, aeronautical, constructional, marine, civil and general engineers, manufacturers of and dealers in plastics, metal and metal goods.

ERINOID, LTD.—The trading profit to July 31 is **£59,755** (compared with **£87,640**). Preferential dividend is **£1,650** and the ordinary dividend of 10 per cent.—**£13,750**. At the meeting, the chairman stated that the reduction in profit is due to the lowering of prices and of profits on Government contracts. Expenditure on repairs has increased.

PERSONAL

MR. GEO. H. HYDES has resigned his position as production manager of De La Rue Plastics, Ltd., owing to ill-health.

DR. M. G. CHURCH has been transferred from the Advisory Service on Plastics and Rubber of the Ministry of Supply to take charge of the corresponding plastics section of the Ministry of Aircraft Production under the Director of Technical Development. He commenced his new duties on August 1.

At the beginning of the war he was in the Synthetic Resins Section of the Chemical Research Laboratory at Teddington. In July, 1940, he was seconded to the Ministry of Supply.

MR. ERIC N. ADLINGTON, after six years' service in the R.A.F., has been appointed Advertisement Manager of Temple Press Limited, and will be responsible for co-ordinating the advertisement policy of the Temple Press Group of publications.

He joined the Company in 1926, and in the years preceding the war was Advertisement Manager of "The Aeroplane," "Light Metals" and "Plastics." Before that he was at various times on the Editorial staffs of "The Motor," "Motor Cycling" and "The Light Car."

PATENT REVIEW

B.P. 570,139. Application date: 3.11.41. Accepted: 25.6.45.

Improvements in or relating to the Extrusion of Thermoplastic Materials. E. G. Williams. To: I.C.I.

Method to prevent the formation of bubbles or voids in the extrusion of polythene as wire covering. This is achieved through a cooling system which is passed by the extruded section immediately following the extrusion die. Water or compressed air are used as coolants. Data are provided for extrusion temperatures, speeds and pressure of coolant.

B.P. 570,331. Application date: 22.1.43. Convention date: U.S.A. 23.1.42 Accepted: 3.7.45.

Improvements in or relating to the Interpolymerization of Vinyl Chloride with Fumaric Esters. E. I. Du Pont de Nemours and Co.

Method for producing polymers by emulsifying vinyl chloride mixed with a di-ester of fumaric acid in an aqueous medium containing a salt of perdisulphuric acid and an acid stable compound, the emulsion being carried out in a closed vessel in the absence of oxygen.

B.P. 570,379. Application date: 22.7.43. Accepted: 4.7.45.

Improvements in Electric Cables particularly applicable for High Frequencies. L. G. Brazier, R. McLeod, C. T. Suchy. Callenders Cable and Construction Co., Ltd. Callender-Suchy Dev., Ltd.

Polythene screened cable for radio-frequency, where the screen is deposited electrolytically to the outer surface of the insulating material. The screen may subsequently be covered with another layer of insulating material.

B.P. 570,649. Application date: 19.9.41. Convention date: U.S.A. 10.10.40. Accepted: 17.7.45.

Improved Compositions comprising Plasticized Polyamides and Articles derived therefrom. E. I. Du Pont de Nemours and Co.

Compositions comprising synthetic linear polyamides plasticized with polyphenols containing at least two hydroxphenyl nuclei separated by a radical containing a chain of at least six carbon atoms are the subject of this invention. The materials so obtained can be used for yarns, fabrics, bristles, for the impregnating of cloth, wrapping foils, raincoats, curtains, etc., also for cans, cups, bottles, etc.

B.P. 570,650. Application date: 19.9.41. Convention date: U.S.A. 8.11.40. Accepted: 17.7.45.

Polymerized Material. Wingfoot Corporation, Akron.

This patent relates to a method of purifying butadiene to make it suitable for use in polymerized materials by removing acetylenic compounds by treatment with mercuric oxide in the presence of water, a mineral acid and an oxidizing agent (e.g., a ferric salt). A material of higher tensile strength, greater elongation and better modulus is thus obtained.

B.P. 570,662. Application date: 28.5.43. Convention date: U.S.A. 14.3.42. Accepted: 17.7.45.

Manufacture of Rubber-like Materials. Imperial Chemical Industries, Ltd.

Process for the manufacture of a polymeric material, mainly of chloroprene and acrylic nitrile. The products obtained may be substituted for natural rubber, but the exceedingly high solvent resistance suggests applications such as for tubing, gaskets and other articles exposed to petroleum products.

B.P. 570,686. Application date: 24.9.43. Accepted: 18.7.45.

Improvements in or relating to the Manufacture of Artificial Filaments, Threads, Films or the like from Protein Solutions. E. I. Jones and W. A. Caldwell. To: I.C.I.

Production of filaments, threads, films, etc., by extrusion of protein solutions into saline coagulating baths of acid reaction. Stickiness of the threads, etc., is prevented by passing them (prior to their insolubilization) through one or more baths which include an aqueous emulsion or an aliphatic lubricant comprising an oil, fat or wax.

B.P. 570,702. Application date: 12.11.43. Convention date: U.S.A. 12.11.42. Accepted: 18.7.45.

Improvements in or relating to the Plasticization of Vinyl Chloride/Fumaric Ester Copolymers. E. I. Du Pont de Nemours and Co.

This patent deals with improved compositions obtained by conjoint polymeriza-

tion of vinyl chloride and a fumaric ester being plasticized with an alkoxyalkyl ester of carboxylic acid having at least two oxygen-bearing functional groups. The compositions obtained can be calendered into sheet or be cast or rolled, extruded or moulded.

B.P. 570,711. Application date: 19.8.42. Convention date: U.S.A. 19.8.41. Accepted: 19.7.45.

Improvements in or relating to the Polymerization of Asymmetrical Dihalogenated Ethylene. I.C.I., Ltd.

B.P. 570,840. Application date: 4.1.43. Accepted: 25.7.45.

Improvements in or relating to the Manufacture of Compound Sheet Materials. J. H. McGill. To: I.C.I., Ltd.

Heat-treating cement for the production of bonded sheet materials consisting of ungelatinized polyvinylchloride paste which is applied to the surface to be joined. Heat and pressure are applied to effect bonding.

B.P. 570,848. Application date: 30.6.43. Convention date: U.S.A. 30.6.42. Accepted: 25.7.45.

Manufacture of Vinyl Halides and like Compounds. E. I. Du Pont de Nemours and Co.

Process for the manufacture of vinyl halides by reacting in vapour phase of a hydrogen halide with an acetylenic hydrocarbon in the presence of a catalyst, preferably gold halide. The latter may be dispersed on highly porous materials, such as clay, charcoal or silicagel.

B.P. 570,857. Application date: 24.8.43. Convention date: U.S.A. 2.9.42. Accepted: 25.7.45.

Improvements in or relating to the Manufacture of Oil- and Grease-resistant Sheets or Films. British Cellophane, Ltd.

Non-fibrous, water-sensitive organic base sheets are coated on one side or both sides with a thermosetting resin that is oil-insoluble and contains oil-insoluble plasticizers. The coating resin is a cellulose derivative and may contain waxes or gums, and various types of plasticizers.

B.P. 570,858. Application date: 25.8.43. Convention date: U.S.A. 25.8.43. Accepted: 25.7.45.

Improvements in or relating to the Production of Linear Fibre-forming Polymers. E. I. Du Pont de Nemours and Co.

Process for the manufacture of linear fibre-forming polymers by heating a mixture containing equi molecular amounts of a diprimary diamine of radical length of at least four and a polycarboxylic acid (tricarboxylic or tetracarboxylic acid) until the product can be formed into filaments.

B.P. 570,867. Application date: 8.4.43. Convention date: U.S.A. 25.8.42. Accepted: 26.7.45.

Co-polymers and Method of Preparing Same. Wingfoot Corporation, Akron.

Method for the preparation of new co-polymers by emulsion co-polymerization of a diene compound (butadiene, pentadiene, or hexadiene) with an alkyl di-ester of monochloromaleic acid containing at least one chloroalkyl radical.

B.P. 570,892. Application date: 21.7.43. Convention date: U.S.A. 2.12.43. Accepted: 27.7.45.

Improved Flexible Impregnated Fabric suitable as a substitute for Rubber or Leather and Method of Manufacturing same. Howard Snow.

Impregnation of a woven fabric with oil-modified thermosetting synthetic resin. After impregnation the surface is abraded in order to remove the rigid crust of the oxidized or polymerized impregnant. A smooth, non-glossy, non-skid surface is obtained in this way. Special grinding machines for the abrading process are described.

B.P. 570,915. Application date: 28.12.43. Accepted: 27.7.45.

A method of and Fluid for use for Marking Polyvinyl Chloride Material. E. Jones and D. N. Hunter. To: English Electric Co., Ltd.

Process for the marking of insulations for electric conductors and, in particular, for marking dark-coloured polyvinylchloride. A suitable solvent (e.g., cyclohexanone) and a pigment (e.g., zinc oxide or titanium oxide), and, if necessary, light-coloured polyvinylchloride are mixed and used for writing or printing on p.v.c.

B.P. 570,941. Application date: 18.11.43. Convention date: U.S.A. 31.3.43. Accepted: 30.7.45.

Improvements in and relating to Polymers of Vinylidene Chlorofluoride. F. G. Pearson. To: The American Viscose Corp.

Method for the polymerization of vinyl chloride by exposure to ultra-violet light or in the presence of a catalyst or both, the catalyst being an organic peroxide and

tetraethyl lead. A trace of uranium oxide may also be present. The products so obtained can be formed into films and filaments by extrusion or by withdrawing from a molten mass of this material.

B.P. 570,990. Application date: 9.7.43. Accepted: 1.8.45.

Improvements in or relating to Mouldable Compositions. J. H. Bennitt.

This invention relates to mouldable compositions consisting of a resinous binder and pieces of woven-glass fabric, the resinous binder consisting of a hardenable phenol formaldehyde resin. Products of greatly increased impact strength may be produced by this process.

B.P. 571,010. Application date: 18.10.43. Convention date: U.S.A. 29.10.42. Accepted: 1.8.45.

Improvements in the Production of Organic Esters of Cellulose. British Celanese, Ltd.

Method for the manufacture of organic acid esters of cellulose by esterifying cellulosic materials with an anhydride or an organic acid in the presence of sulphuric acid as catalyst. The product so obtained is ripened in the presence of sulphuric acid, the cellulosic ester precipitated, redissolved and ripened in the presence of an aliphatic polycarboxylic acid.

B.P. 571,017. Application date: 15.3.43. Convention date: U.S.A. 21.10.42. Accepted: 2.8.45.

Polymeric Condensation Products from Aminoalcohols and Dicarboxylic Acids. Wingfoot Corporation, Akron.

Method for the preparation of resins by heating a dicarboxylic acid (sebacic, adipic or succinic) or anhydride, with aminoalcohols (maleic or phthalic anhydride) in the presence of a liquid hydrocarbon at temperatures between 150-220 degrees C.

B.P. 571,018. Application date: 13.5.43. Convention date: U.S.A. 13.5.42. Accepted: 2.8.45.

Improvements in or relating to the Production of Pigmented Linear Polyamides. E. I. Du Pont de Nemours and Co.

A process is described for the production of pigmented linear polyamides. An aqueous dispersion of a pigment containing a protective colloid and a polyamide-forming material are heated under correct conditions so that the polyamide is formed. As polyamide-forming materials, the following are specially mentioned: The salt of a diamine and a dicarboxylic acid (e.g., hexamethylene diammonium adipate).

B.P. 571,071. Application date: 22.10.43. Accepted: 3.8.45.

Improvements in Injection Moulding Machines. R. E. Windsor and E. Gaspar.

Injection moulding machines with a number of individual dies and corresponding plungers which line up individually when the press closes. Advantages: Small injection volume of each die, higher operating speed, ease of moulding.

B.P. 571,494. Application date: 31.1.42. Convention date: U.S.A. 10.9.41. Accepted: 28.8.45.

Rubber Composition. Wingfoot Corporation.

Comprises an improved composition of low protein rubber and cyclized rubber, the latter amounting from 5 to 50 per cent. of the total mass, the cyclized rubber being manufactured by heating rubber with tin tetrachloride, amphoteric halides or hydrochloric acid in the presence of a solvent. The new product is easy to extrude, has a low moisture absorption and will hold its shape after forming.

B.P. 571,495. Application date: 3.2.42. Convention date: U.S.A. 5.9.41. Accepted: 28.8.45.

Synthetic Rubber Composition. Wingfoot Corporation.

This invention discloses a rubber composition of improved abrasion resistance and lower plasticity than that of unmodified synthetic rubber. The composition comprises a synthetic rubber, a butadiene-acrylonitrile co-polymer and cyclized rubber (the latter being 25-75 per cent. of the total rubber). (See also B.P. 571,494.)

B.P. 571,496. Application date: 25.2.42. Convention date: U.S.A. 26.2.41. Accepted: 28.8.45.

Improvements in and relating to Resinous Compositions. The British Thomson-Houston Co., Ltd.

Relates to the production of new resinous compositions for moulding, casting, coating and for use in adhesives. It applies especially to compositions of diallyl-phthalate containing 1-5 per cent. benzoyl-peroxide and 5-10 per cent. of copper. By heating this composition to 100 degrees C. for a short while a very viscous mass may be obtained, which, after removal of the copper, can be further polymerized by adding 1-6 per cent. benzoyl-peroxide and heat.

Planned Mould Maintenance Service Aids Economical Production

Section XVI (Contd.)

By W. M. HALLIDAY

Points to be Watched by Operator and Maintenance Toolmaker

The maintenance attention likely to be required with a mould of this simple construction is but small, especially if reasonable care is exercised both by the machine operator and the persons responsible for loading, unloading, cleaning, and generally handling the magazine plates.

Nevertheless, it will probably be most helpful briefly to describe some of the chief points from which troubles are likely to come in the form of wear, warpage, undue slackness, misalignments, seizures, stiffened working of mould members, excessive flash-over, inadequate parting-line seal and so forth. These points then will be as follow.

(a) The maintenance toolmaker will have to ensure that a sufficiently close working fit be constantly retained between the sides of the magazine plate and those of the recess in the mould block in which the plates seat. Obviously this will be considerably easier than in the case of dowel location and fitment contained in the previous example already discussed. The actual surface area in close contact between the two mould members shown in Fig. 3 (see October issue) will be much larger than that obtained from location on four small circular dowels. Hence any wear action will be spread over this larger area, and consequently will be normally much better avoided.

(b) Very frequent checking should be made for the security of fixing of the stop plate on the lower edge of mould block. If this member becomes loosened, distorted or bruised on its upper surface, against which the bottom end of the magazine plate has to contact, this latter member will be incorrectly aligned in respect of the mould cavities. This stop piece should preferably be well hardened, and afterwards surface ground dead flat, being fastened both by set screws, readily accessible, and dowels. The operator, too, will have to be instructed to watch this member to ensure it is kept perfectly clear of particles of dirt, oil, moisture, corrosion and so on.

(c) The stripper rods and ejector pins should also be given a regular inspection, both for security of their fastening to their respective plates and also for smooth, non-bruised surfaces and free sliding action with the mould block and other members. If the stripper rods are allowed to become distorted there will be a danger of faulty ejection, due to the ejector plate not being operated in a straight-line path. The ejector pins also may become broken or, at best, their working considerably stiffened, which factor will pave the way to more serious troubles still, such as seizure and badly scored guide holes, or complete breakage of pins.

(d) The magazine plates should also be regularly inspected and tested to detect warpage, so as to obviate all risk of parting-line flash-over, due to faulty sealing of the blocks. In some cases it may prove advisable to relieve the surface of the magazine plate at points remote from the edges of the mould cavity, in order to secure a concentration of the clamping pressure upon a smaller sealing land area. The depth of such relief lands should, of course, be made extremely slight, of the order of .008 in. as a maximum, otherwise with too deep machining serious weakening of the plate may result.

(e) In those mould designs where portions of the cavity are actually contained in the face of the magazine plate, especial care will be required to ensure that the insertion of the pre-formed insert com-

ponent does not inflict damage to the highly polished surface walls of the cavity or to other important sharp corners, etc. But in actual practice it will be found that use of such a magazine plate capable of being loaded separately from the mould will conduce to greater safety in this respect.

For similar connected reasons care will have to be exercised when storing and handling such magazine loaders as distinct from their normal usage. The writer is very painfully conscious of costly damage caused to essential cavity edges or surfaces because of inconsiderate handling or storing actions. It should be appreciated that the same amount of care and discretion is required for the transport, storage and handling of these vital and time-saving mould auxiliaries as that needed for the care of the moulds themselves.

(f) The successful operation and functioning of the type of pre-loading device described depends to a large extent upon the degree of cleanliness and effective lubrication provided, so that the necessary sliding movements shall take place with a maximum of freedom and an absence of binding or dragging action. Therefore very frequent checks should be made to see that dirt or other foreign substances are not accumulating on the mechanism to foul important movements. The construction is of such a type as readily permits such operations being performed without removing the mould from the machine or dismantling the pre-loader.

It will be appreciated that this type of pre-loading mechanism is one offering wide possibilities for easy adaptation and application to injection moulds. Many very useful advantages may be obtained. For example, large numbers of insert components can be effectively and rapidly dealt with by means of a device of this type, where, of course, innumerable seatings for inserts can be provided within the capacity of the base plate. In dealing with a variety of shapes and forms of insert parts, the possibilities of this mechanism are equally diverse. Thus, cylindrical studs, pins, sleeves, tubes, circular discs, etc., whose use abounds in plastic moulding, as well as inserts of other less usual shape, can all be economically handled in respect of quick location into the mould cavity by pre-loading devices similar to those already described.

A Removable-type Pre-loader Ensuring Accurate and Speedy Feeding

We pass now to the consideration of yet another extremely interesting and useful kind of insert feeding arrangement which

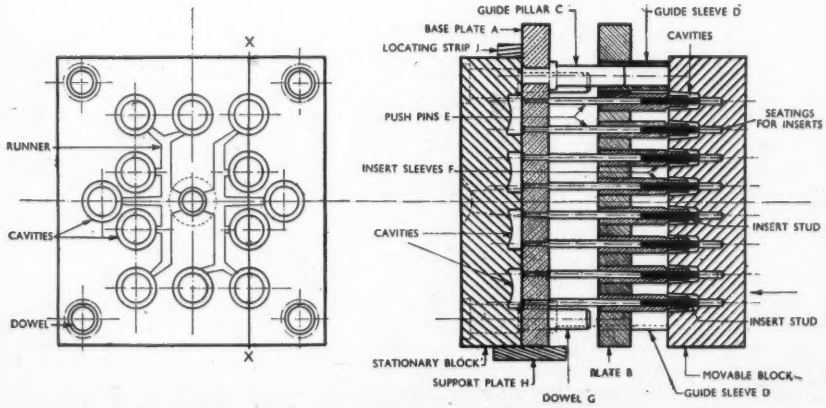
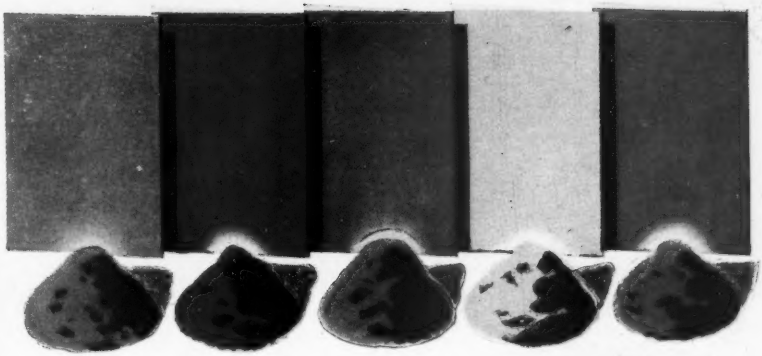


Fig. 4.—Plan view of stationary block on parting line. Section on line XX



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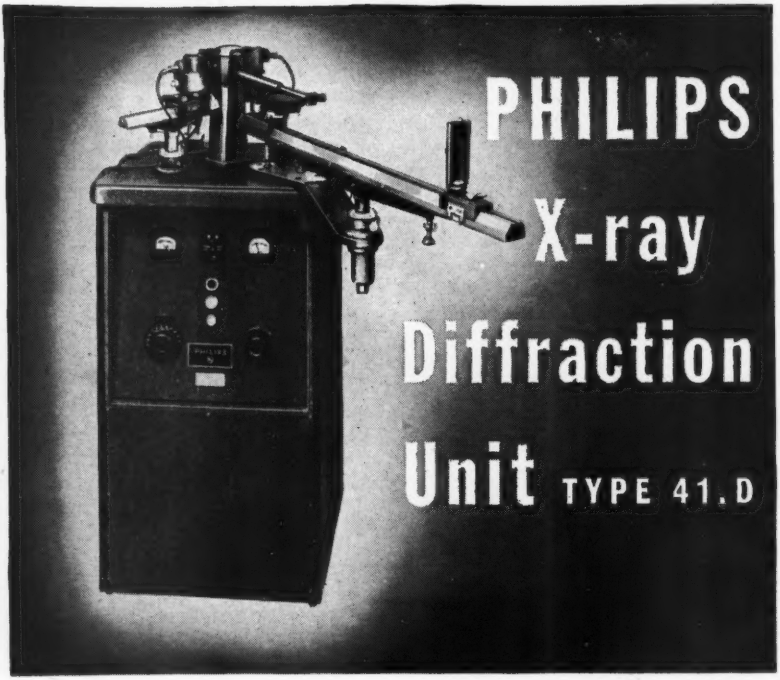

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has many different applications, but it is particularly applicable to multi-impression moulds, where each cavity is characterized by long depth and small diameter, which factors make manual feeding of inserts difficult.

Turning to the illustrations shown in Fig. 4, it will be noted that the left-hand view is that of the stationary mould as seen looking at the parting-line surface. This view is given to indicate the disposition of the 12 cavities in relation to each other and to the runner. Only the head portion of the knob moulding is contained in the stationary block. Two long boss extensions have to be formed on this head piece, each extension carrying a small brass pin, which is to be moulded securely in place and allowed to extend a predetermined amount. The cavity formations for these boss extensions are contained in the movable block. This will be more clearly understood by reference to the right-hand sectioned cut of the completely assembled mould and the pre-loader arrangement. The sectional view follows line XX passing through four of the cavities.

The pre-loader device is interposed between the opened mould blocks in the manner illustrated, after first being filled with the requisite number of insert components, in this instance 24, it being so arranged that the normal closure movement of the blocks suffices to eject all the inserts accurately and to the correct degree into their respective seatings at the bottom of the cavity. To accomplish this the blocks are closed until the pre-loading device has also been closed to its limit, then the blocks are slightly opened to allow the pre-loader, now empty, to be completely taken away, after which the mould blocks are fully closed and the injection shot made.

It will be appreciated that an operator would encounter considerable difficulties and irritations in having to manipulate 24 small cylindrical insert pieces into the deep cavity formations of this mould, whilst the time absorbed in that task would very greatly diminish output.

One important point is stressed at the outset of the description of this device. The keynote of this type of pre-loading mechanism is its simplicity of construction and small number of working parts, which results in a device relatively free from serious operating snags and capable of giving prolonged trouble-free service. Unnecessarily complicated feeding and locating devices for facilitating the handling of inserts are not to be recommended because invariably these involve maintenance service or attention out of proportion to that needed to keep the moulds themselves in sound working order. This, incidentally, is a design aspect well worthy of the closest attention of the designing engineer.

Referring to the sectioned right-hand view in Fig. 4, the pre-loading device is shown in position within the open mould blocks, which latter are ready for closing inwards so as to eject the insert pins from the holder into their seatings in the movable block.

The loader comprises a base plate A and a sliding plate B. The overall dimensions of both these plates are identical and also match up exactly with three sides of the mould blocks. On the top side only are the plates extended so as to project beyond the edge of block. The purpose of this extension is to allow for better holding of the device during loading to blocks and vice versa, as will be explained later.

Plate A is equipped with a set of guide pillars C, which members should preferably be shouldered and made of ample stiff proportions so as to resist all tendency to deflect or bend under load.

These pillars are secured very tightly to the base plate A, and, moreover, should be of such a number and so disposed as to allow the sliding plate arranged thereon perfectly free movement along the pillars.

Thus, the pillars should be fairly widely spaced at centres greater than those of the insert locations.

The sliding plate B is equipped with specially hardened guide sleeves D for engagement with the guide pillars. These

sleeves should be a press fit within the plate B.

Also permanently secured to the base plate A by riveting are the push pins E. These are silver steel cylindrical rods slightly reduced in diameter at one end so that a shoulder is provided by means of which a more secure fixture to the base plate is obtainable. The spacing of these push pins is made exactly the same as that required of the inserts in the finished moulded article. These push pins pass through the long insert sleeves F, which are driven tightly into the sliding plate B, and, of course, extremely close matching for hole centres, the base plate drilling, etc.

It will be noticed that the right-hand end portion of each sleeve F is projected into the mouth of the mould cavity, it being reduced slightly in diameter to give adequate working clearance at this point. Up this end of each insert sleeve is housed the insert itself, as is shown by the solid black shading. Endwise positioning of the insert piece is obtained by allowing it to abut against the end of the push pin E when the two plates A and B are in their correct open location.

The entire pre-loader is located upon the four ordinary dowels of the mould blocks G, guide holes being drilled in the base plate A for passing on to these members, which also serve to position the pre-loading mechanism correctly in respect to the mould cavities in the blocks. In addition, a locating strip, as at J, is attached to the left-hand face of plate A, and so disposed as to bear very lightly on the top edge of the stationary block when the plate is led on to the dowels. This serves to maintain the pre-loader square whilst being led on to the dowels. Another useful adjunct is the support plate H, which is secured to the bottom edge of the stationary block, as shown. The purpose of this member is to afford a rest for the whole pre-loading device, whilst it is being aligned up for meshing with the four dowels. This will be found especially desirable in cases where the pre-loader is of bulky dimensions or great weight.

Operation of Removable Pre-loader

As in the case of the previous examples, Figs. 1 to 3, a number of these pre-loaders should be supplied for each mould. Where production is extremely rapid, it might be advisable to provide three or even four in order to keep the injection machine running to full capacity. Two such devices will generally be the minimum number to maintain production. One is being loaded up whilst the other is in the machine.

In use, the sequence of operations will be somewhat as follows. After the finished spray of mouldings has been ejected, the mould blocks are left open for a few moments whilst the machine operator is handed a fresh pre-loader filled up with its complement of insert components. It will be handed to him in the position actually depicted in Fig. 4. He has to place this in correct position over dowels G on the stationary block. Then his next action is to close the mould a certain amount, which will coincide with the closure of the plates A and B, the latter sliding along pillars. This action causes the push pins fixed to A to push out the insert studs, which pass down the cavity and into the required seatings provided for them in the movable block. Plate B should be arranged with sufficient movement as will cause complete ejection of the inserts from the sleeves F. This done, the movable block is slightly opened sufficient to allow the pre-loading device to be withdrawn from dowels and extracted from the mould opening, after which the blocks may be fully closed, an injection shot made, and the moulded articles ejected in the normal manner.

The stud inserts are thus rapidly, safely and correctly directed into their respective seatings in the moving block without trouble or juggling about, such as distinguishes purely manual insertion.

Advantages and Other Features of This Pre-loading Mechanism

This illustration of a simple typical pre-loading mechanism is given chiefly to indicate the general design and construction principles employed, and to show

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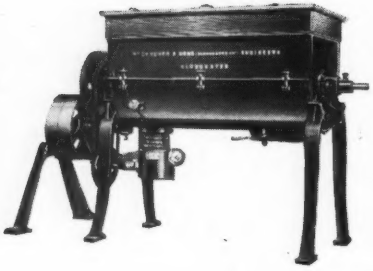

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how, in an inexpensive manner, difficulties of loading or locating inserts can be overcome.

At the same time, in its present form it is realized this device does possess numerous drawbacks likely to prove of some worry to the mould maintenance engineer under whose care such a device will come. It will, therefore, be most helpful if the advantages and disadvantages of this type of mechanism are described, so that some of the possible obstacles to efficient operation may be avoided.

Taking first the matter of advantages, several of the more apparent ones as affecting speedy operation and easy access of the insert stud will have become apparent during description of the device.

A second advantage worthy of note is that by adaptations to the shape of the projecting portions of the insert-holding sleeves F, even the most awkwardly shaped cavity formation can be bridged to give feed for the insert seating.

Thirdly, in the case of very slender types of inserts these sleeves can be so arranged as to give ample support almost up to the entrance of the insert seat itself. Thus there is little risk of the insert lying out of line with its seating, and making faulty engagement therein when the device is operated.

By adjusting the lengths of the push pins it is readily possible to deal with metal inserts of different lengths within the same mould. Similarly, with respect to the length of stroke permitted to the plate B, if means are provided whereby this distance can be varied within limits, the capacity of the pre-loader will be still further increased.

Fourthly, because of the simplicity of its construction, this mechanism operates with extreme smoothness and also at a speed commensurate with that of the injection mould itself. The working parts are kept very few in number, and there is, indeed, little that can go seriously amiss.

The troubles likely to arise are almost exclusively those connected with certain undesirable features of the construction rather than the principles of design, and these will now be enumerated.

(1) In a device of this character distortion is apt to prove one of the worst snags during operation. Hence to keep this tendency at a minimum, both main plates comprising the device should be of very ample thickness. Very thin base and sliding plates will only add to the inclination towards distortion and stiffened working of all the sliding parts.

(2) To the same end the sliding plate should be very substantially guided on robust pillars, which latter should be correctly spaced both in relation to the mould cavities being dealt with and to the points of pressure imposed on the device when being closed. It would be asking for operating troubles if, for instance, these guide pillars were to be located at one side only of the horizontal centre line of the blocks. They should be disposed so as to balance out the pressure and to ensure free sliding movements.

(3) Provisions should also be made to take up any wear occurring on the guide pillars, otherwise serious misalignments of the two plates composing the pre-loader might occur. For this reason it is recommended that hardened steel bushes be used in the slider plate as shown. But some drawbacks are to be noted in respect of the fitting of these members in the present instance. Thus they are not shouldered, and since the pressure of the closing mould block bears directly upon the right-hand end of each guide sleeve, there is a distinct tendency for these members to become moved out of correct position. Should this occur, the pressure upon the arrangement will immediately be unequalized, with the result that the sliding plate B will tend to move crosswise on its guides, and the consequent risk of bending or breaking the push pins. These sleeves, then, should preferably be shouldered and very firmly affixed to the plate.

(4) In order to secure prolonged correct location of the entire device on the stationary block and its dowels, where this form of fixture is utilized, it will also be advisable to line out the holes in plate A with renewable hardened bushings.

(5) Similar difficulties are prone to arise in connection with the method of fixing the insert sleeves F to the slider

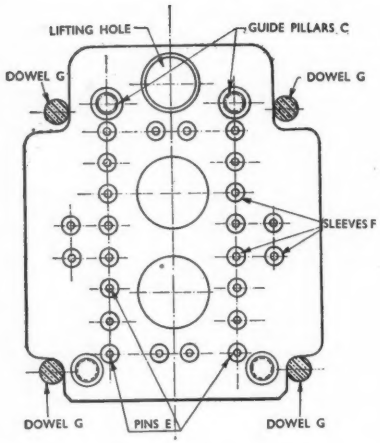

Fig. 5.

plate. Here again these are simply parallel tubes driven tightly into the drilled plate. Should these become disturbed in their setting they may foul the cavity mouth or become pushed back an undue amount so as to permit too much overhang of the insert stud. These sleeves should preferably be made of the shouldered kind located with the shoulder portion taking the main thrust and pressure during operation.

(6) Yet another disadvantage will be found in respect of the method of locating this mechanism upon the dowels in the stationary block. In actual practice the writer has found that the task of engaging a pre-loading device of this kind with four dowels is one that usually entails not a little manipulation, due to the tendency of the loader to get crossed over the dowels before sufficient length of engagement has been obtained. To avoid all such troubles the writer has employed with signal success the method of location depicted in Fig. 5.

By referring to this illustration, which shows a plan view of the base plate A for the same mould as in Fig. 4, it will be seen that location of this plate with the stationary block is secured from the dowels in the following manner:—Step portions are machined on the bottom side of the plate, these being very accurately marked out to suit the position of the dowels, and radiused out as shown. These steps then allow the plate to rest upon the dowels in its correct position. With regard to the two upper dowels, the plate A is similarly narrowed down, so as just to pass between the dowels.

By this means of location the whole insert-feeding device can be very rapidly yet accurately located, whilst the act of mounting it only takes a few seconds in contrast to the several minutes apt to be required by the other method mentioned.

From Fig. 5 it will also be noticed that the plate A is suitably drilled, first with a large hole near its top edge for lifting purposes. This allows the operator to get a secure finger grip on the plate during mounting or removal from moulds. Then two other very large lightening holes are machined through the body of the plate at convenient points.

Positioning of Pre-loader

As regards the positioning of the type of pre-loader, there is, of course, no reason why the method described and illustrated in Fig. 3 should not be used with advantage. Cases may be encountered, however, where it is not possible to machine the parting-line surface of the stationary block in such a manner, hence the writer offers suggestions of alternative methods, as in Figs. 4 and 5.

(7) On the construction shown in Fig. 4 no provision is indicated for the return of the moving plate B to its proper open position after a set of inserts has been fed to cavities. This will prove an important point because if no effective and foolproof method is installed the loading operative may experience trouble in opening the device to the required degree of uniformity each succeeding time. Also definite limit stops should be made to prevent the plates being opened too far.

Several methods may be used to ensure this being properly performed each time of handling. Thus, powerful coil springs may be used interposed between the two plates so that once the pressure of the

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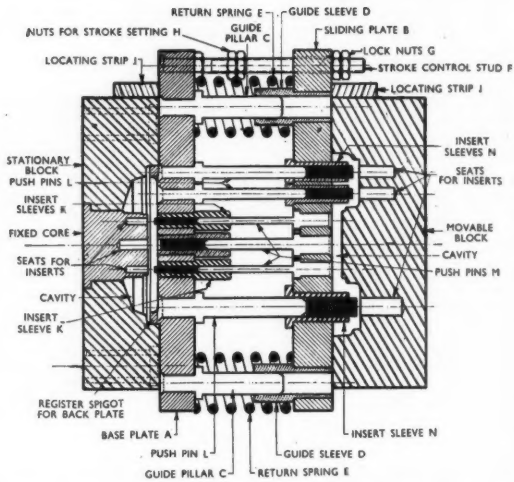

Fig. 6.

closing mould blocks is removed the pre-loader mechanism automatically opens.

Or if spring action is not considered advisable, purely mechanical means can be obtained by inserting through the base plate A a number of parallel cylindrical return pins long enough to bear against the inner face of plate B when in open position, and at their other end to come flush with the left-hand side of plate A.

As the mould blocks and pre-loader close, these return pins are actuated, being pushed clear of plate A. When the mechanism is removed from moulds and placed on the cleaning and loading table adjacent to machine, it is simply placed on the table with plate A flat down, and its own weight will then force the return pins in that member to move backwards until flush with end face thereof, thereby causing the sliding plate B to be returned to its correct loading position.

Adapted Pre-loader for Feeding Inserts into Both Mould Blocks

Before leaving the discussion of these kinds of pre-loading mechanism one very important and valuable adaptation should be mentioned. This is illustrated at Fig. 6, which shows a completely sectioned view of a composite-type mould which has extensive cavity formations in each block. Into each portion of the cavity three inserts have to be moulded as indicated by solid black shading.

The pre-loading mechanism has been simply rearranged so as to effect rapid and accurate insertion of the insert components into these cavity seatings, and also various other interesting modifications or improvements are shown.

A and B are the stationary base plate and sliding plate respectively, the latter being arranged to move along a controlled track by reason of the guide pillars C. It will be noted in passing that this plate is fitted with shouldered guide sleeves as before described.

Around these guide pillars and their sleeves, in each case, is housed a stiff compression spring E needed to ensure the return of the sliding plate B. The amount of movement of this plate is controlled by means of a fixed stud F, secured down to plate A and passing through a clearance hole in plate B. This stud is threaded for a major portion of its length to receive the four lock-nuts G and H respectively. Those at G, to extreme right of plate B, are needed to regulate the open position of the plate with respect to A. Nuts H are capable of being set and locked in any desired position on the stud and form a stop for the inward travel of the plate B. Thus the amount of stroke, and end stop points, can be determined within certain limits. The advantages of these provisions will be apparent.

To facilitate setting the pre-loader

device on to the stationary block, a locating strip or plate as shown at J is fastened permanently to the left-hand face of A.

The device via plate A is located on the stationary block by means of a registering spigot machined on its left-hand face and made in diameter a snug slip fit within the mouth of the mould cavity. The strip J enables the fixture to be held at the correct height in relation to mould cavity centre before the spigot portion makes engagement therein; thus, setting is simplified.

Three insert housing sleeves as at K are secured within the plate A for handling the insert pins needed for the cavity portion in the stationary block. Also three shouldered push pins L are firmly riveted to this plate and pass through insert sleeves N, secured to the slider plate B. Into this latter plate the three push pins M are riveted at their shouldered ends, these latter then passing through insert sleeves K, tightly secured into plate A. All push pins and their sleeve guides are, of course, correctly disposed to match up with the centres of the insert seats in the respective blocks. The insert components themselves are shown in solid black shading.

The noteworthy features possessed by this arrangement are as follow:—

First as to location: this is made direct with the cavity itself, and thus, where possible, ensures the maximum accuracy and correct alignment with the cavity wherein inserts have to be placed. Some care will, of course, be required in this type of pre-loader location, otherwise the mouth of the mould cavity may become bruised or even worn after some time. To avoid this condition the spigot portion on the plate A could be made up separate in ring form and attached to a recess in the plate. In this manner it will be possible to make the register spigot from brass or similar non-bruising material.

By providing a stroke control device the length of stroke of the plate B is controlled sufficiently to render the preloader adaptable to a wide variety of insert dimensions.

It will also be noted that the contact ends of the push pins L and M respectively are tapered down to impart a small amount of lead and also to obviate any sticking tendencies which might otherwise arise after some use, due to the slight mushrooming of the pin ends after prolonged contact with the ends of insert components.

If desired it will also be possible to arrange the insert holding sleeves of the split spring type so that a spring tension of light magnitude is given to the insert part which will be sufficient to prevent it from falling out or becoming wrongly positioned by its own weight during transit from loading table to moulds. In a previous section this type of insert pin retention was described.

Maintenance Service Required

As in the previous instance the attentions of the maintenance engineer will be concentrated upon early detection of signs of wear between the guide pillars and their sleeves on which the moving half of the pre-loading device functions. Similarly with respect to the push pins and their sleeves, these will require some attention to ensure due cleanliness, straightness and freedom of sliding movement, whilst the sleeves will have to be tested at intervals for true positioning. But if kept reasonably clean, well adjusted, and lubricated, there is nothing in this mechanism which should go seriously wrong, especially if the device is made in the first place in accordance with well-known toolmaking practices as to fits and so on.

In the safe use of all these devices there will, of course, have to be due consideration given to the loading and unloading facilities, in the form of suitable tables and cleaning tools, and in this connection the maintenance toolmaker should be consulted and allowed to advise on the most suitable kind of apparatus to install with a view to conserving the surface finish, accuracy, and free movements of the constructions.

Other Adaptations

It will be appreciated that these constructions are only applicable to mould

layouts where the insert component is located within the cavity along a plane situated 90 degrees from the parting-line surface of the blocks. But it is often commonly required to locate an insert at an angle other than 90 degrees to the parting line. The ingenious mould designer will readily envisage simple modifications to the designs here illustrated and described whereby such situations can be effectively covered.

In point of fact, such constructions have been adapted for precisely such purposes as these, these adaptations briefly consisting of means whereby the horizontal movement of the closing mould block is utilized in such a way as to obtain therefrom the requisite inclined movement to the sliding portions of the pre-loader to deliver the insert parts at the correct angle and to their proper place as the mould is closed in a manner already described in relation to the present designs.

The next section will therefore be devoted in part to these problems of inclined location of inserts and how they may be overcome, and the author will present a number of typical illustrations of mechanisms which have been successfully employed for such purposes in the hope that interesting guidance suggestions will be afforded to the mould engineer.

Also in the next section it is intended to deal with another aspect of insertion mould design, namely, that which is of such a form as allows for gravity feeding of the insert components. Very often mould designs are encountered which are of such a type as to render them specially suited for delivery of the inserts by automatic gravity feed, as distinct from separate magazine plate feeders already dealt with. Such a form of feed is usually particularly valuable when applied to multi-impression moulds, and where the inserts are of such a size and shape as conform to gravity feed.

It is hoped, therefore, to devote a good deal of attention in the next section to these mould devices, which are of particular interest and concern to the maintenance toolmaker, involving, as they do usually, some added complication of mould construction, greater care in operation, and increased ways in which troubles and operating snags may arise.

Furthermore, some mould constructions are more suited to insert delivery by means of a fully automatic mechanically operated feeding device in preference to the gravity feed, and some attention will be given to representative designs which have been proved of practical value.

PLASTICS IN SOUTH AFRICA

(Continued from p. 548)

able fibres, moulded, cemented or built-up articles of great size and strength may be produced." In other countries during the war immense advances have been made in the plastic field. Softwoods impregnated with plastics have become a material of construction superior to hardwoods and capable of replacing metals for many purposes. The South African Forestry Department has shown that in some districts some softwoods grow with phenomenal rapidity, and recently Dr. H. H. Bennett, of the United States, when asked if he could suggest any product which South Africa could grow better than any other country, said he believed that in production of softwoods she might lead the world. Softwood production alone might not seem a very satisfactory aim, but with the simultaneous development of a plastics industry, impregnated softwoods and other quick-growing fibrous materials it could become a major export industry, which could be in full-scale output within 20 years. "As formaldehyde is obtained by dehydrogenation of methyl alcohol, it is being made on a large scale overseas from natural gas, the establishment of a plastics industry based on formaldehyde does not depend on the methane supplies available. If large supplies of methane are available, methyl alcohol and formaldehyde may be produced from these sources, as has been shown by the pilot plant at the Johannesburg municipal laboratory." The Department of Commerce and Industries asked at the end of 1943 that this plant should be developed, and the first small output of methyl alcohol was obtained last March.

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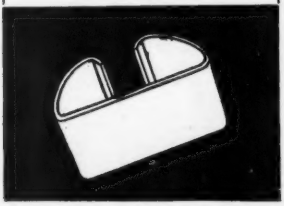

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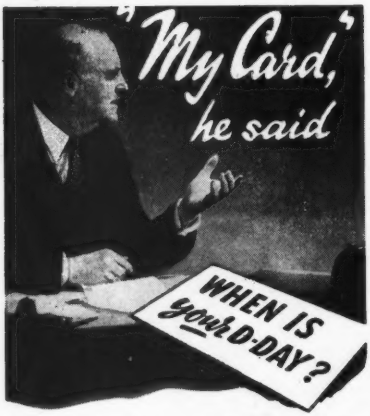

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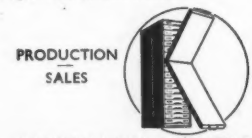

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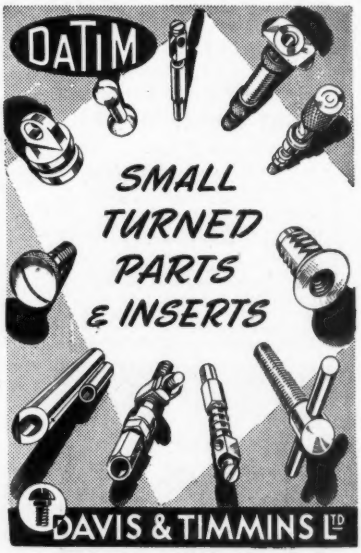

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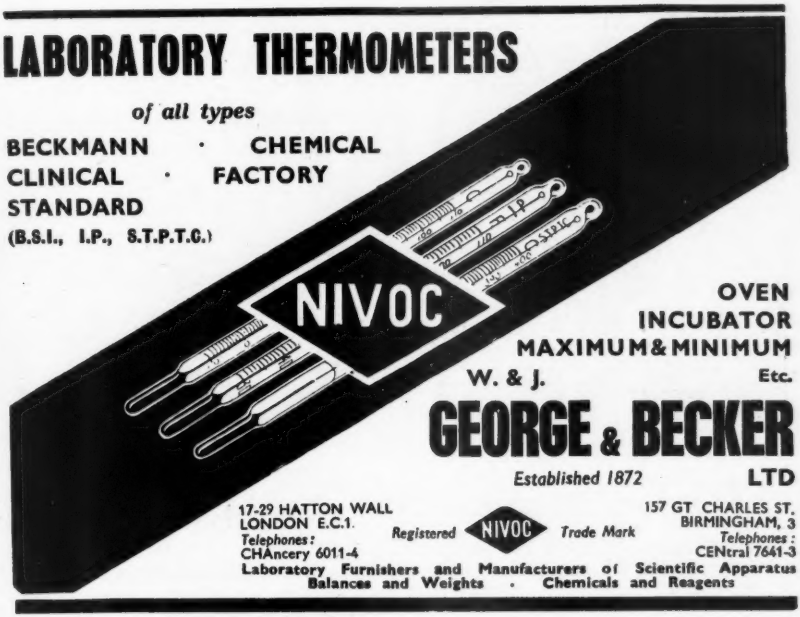

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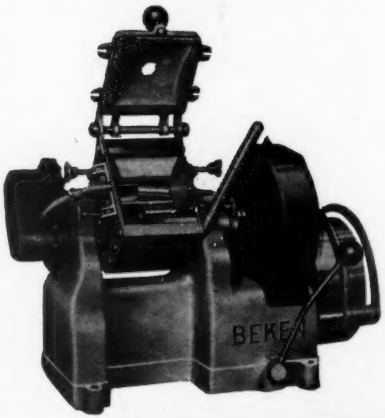

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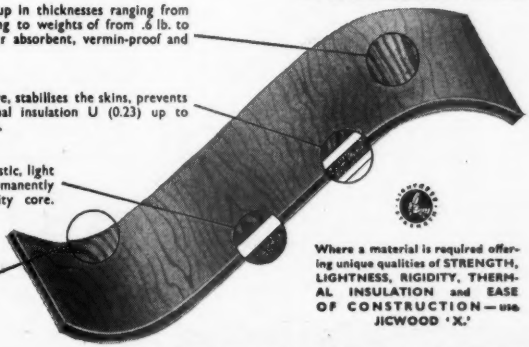

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Acetate and Nitrate. Sheet off-cuts and scrap plastic materials of every description wanted. We can arrange collection. Top prices paid. Lloyd's, 72 Bridge Street, Christchurch, Hants. Phone, Christchurch 504. zzz-51

Wholesalers wish to contact manufacturers of plastic goods for domestic use. Frigonia, Ltd., 10-12 Copthall Avenue, London, E.C.2. 102-4604

Urea Powder, small or large quantities, any colour, required for export moulding orders. Box 7269, care of "Plastics." 102-4603

Merchants with established wholesale connection require mouldings of own design. Tools supplied if necessary. Write, Box 3285, Frost Smith Advtg., 64 Finsbury Pavement, E.C.2. 102-4645

London Wholesalers, serving 300 shops (not obsessed by export business), requires supplies of coloured and white tea cups, saucers, egg cups, ashtrays and allied plastic goods. Continuing business assured. Box 7863, care of "Plastics." 103-4856

Urea and phenol moulding powder, in all colours, urgently wanted. Box 7856, care of "Plastics." 102-4859

Consulting plastics engineer with 12 years' experience, development, processes and testing, invites inquiries. Box 8228, care of "Plastics." 102-x4398

Modern Extruding Machines, large size, Francis Shaw or similar. Box 8328, care of "Plastics." 104-5067

Export firm, with agencies in Egypt, Syria, Turkey, Persia and India, invites offers of metal and plastic furniture, utensils, etc., etc., for export. Send catalogue and best export price list in first instance to Box 15, care of Pool's, Aldwych House, London, W.C.2. 102-6

Well-known factors with large selling organization desire to contact plastic manufacturers wishing to place their products in large quantities. Anderson and Page, 20 Fitzroy Square, W.1. 102-7

Manufacturers' Agent, 12 years' experience, Malaya, Siam, Burma, Indo-China and Dutch East Indies, wishes contact exporters, particularly plastics manufacturer. Communicate Malaya, Box 1749, G.P.O., Sydney, Australia. 102-14

Wanted—*contd.*

Wanted, quotation for making boxes in wood, metal, or synthetic, size approx. 17 ins. by 11 ins. by 3½ ins. Pencarbon, Hallaton Street, Leicester. 102-17

Established manufacturer desires contact manufacturers of plastic fabrics, suitable for toilet bags, cot sheets, etc. Box 8295, care of "Plastics." 102-x4627

MISCELLANEOUS

400-Ton Vertical 4-Column 4-Daylight Upstroke Hydraulic Press by Shaw, ram 16-in. dia. by 30-in. stroke, maximum daylight 48-in. working pressure on ram 2-3 tons per sq. in., 5-in. dia. columns, complete with five new steel steam-heated plattens, 72 ins. by 51 ins.

635-Ton Vertical 4-Column Hydraulic Press by Shaw, ram 18-in. dia. by 54-in. stroke, maximum daylight 6½-ft. working pressure on ram 2½ tons per sq. in., table 72-in. by 48-in., columns 7-in. dia. (two available).

400-Ton Vertical 4-Column 15-Daylight Upstroke Hydraulic Press by Rose, Downs and Thompson, ram 16-in. dia. by 26-in. stroke, 6-in. dia. columns, working pressure 2 tons per sq. in., complete with steel plattens, 35-in. by 24-in. by ½-in. thick.

50-Ton Vertical 4-Column Upstroke Hydraulic Press by Planters Eng. Co., ram 8-in. dia., side return rams 1½-in. dia., complete with two thermostatically controlled electrically heated mild steel plattens, Fraser Mono-Radial Pump and 3 h.p. motor 400 volts 3-phase 50 cycles, all new 1945.

Harland Multi-stage Low-pressure Hydraulic Pump, direct coupled to 175 b.h.p., Harland motor 400 volts 3-phase 50 cycles 2,950 r.p.m. with starter, 4-in. suction and delivery, capacity 300 g.p.m. at 500 lb. pressure, new 1942.

Vertical 6-Throw Hydraulic Pump by Mills, rams 2½-in., 2-in. and 1½-in. dia. by 6-in. stroke, mounted on tank bed and vee rope driven by 25 h.p. B.T.H. slip ring motor, 400-volt 3-phase 50 cycles, 960 r.p.m., with starter, working pressure 2 tons per sq. in.

Horizontal 4-Throw Hydraulic Pump by Planters Eng. Co., rams 2¼-in., 1⅝-in., 1⅛-in. dia. by 2½-in. stroke, mounted on tank bed, vee rope driven from 8 h.p. Brook motor, 400 volts 3-phase 50 cycles, with starter, 2 tons per sq. in. pressure, new 1942.

Newman Industries, Ltd., Yate, Bristol. 103-4853

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Moulds. Grained embossing plates and rollers. J. Martin and Sons, Ltd., Ardwick, Manchester, 12. 110-4421

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Miscellaneous—*contd.*

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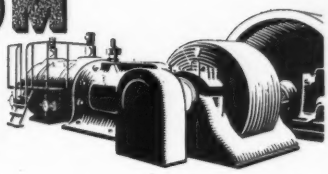

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